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# North Face

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Academic Journal of Darjeeling Government College



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The Journal is an interdisciplinary, peer reviewed and refereed academic journal of Darjeeling Government College, a new noble initiation of the teachers in the academic field. It brings out research based articles/papers on diverse fields, comprising of natural science, social science, humanities, commerce and economics, having significant contribution on the development of research and academic activities. Theoretic papers as well as hardheaded papers are welcomed for the betterment of academic activities and of research field as well. The essence of journal is to hike up search for knowledge with academic rigor.

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## Guidelines to Authors

**NORTH FACE** welcomes submissions that explore not only the coeval issues of Natural Science, Commerce and Humanities & Social Science but also search the *modus vivendi* of the northern parts of India. The journal will primarily target the students and the general readers as well. The style of writing should be lucid so as to attract readers from diverse backgrounds.

A Reviewing Editorial Board will first assess all the papers. The papers found unsuitable in terms of overall requirements of the journal will be returned to the authors for necessary correction and must be resubmitted within the stipulated period. The submitted contribution should not have appeared elsewhere.

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- 7) The text of the article should have a brief introduction and must be written in simple as per as practicable. One can break up the text into logical units, with readily understandable headings and subheadings.
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**Macfadyen,A.(1963):** The contributions of microfauna to total soil metabolism. In: Soil organism, J.Doeksen and J.Van Der Drift (Eds). North Holland Publ. Comp., pp. 3-16. [For book chapters]

For literature group one can follow the instruction given in the latest edition of MLA handbook.

## From the Desk of Editor-in Chief

I am really honoured to have been chosen as the first Editor-in-Chief of ***NORTH FACE***, a new-fangled academic journal of Darjeeling Government College.

***NORTH FACE*** welcomes submissions that explore not only the coeval issues of Natural Science, Commerce and Humanities & Social Science but also search the modus vivendi of the northern parts of India.

In fact, Darjeeling Government College has a very arousing history of journal. Looking back at the recent past of Darjeeling Government College ventilates a picture that from 1982 to 2001, the college had published a journal on natural science, named as “Journal of Bengal Natural History”(ISSN:0409-0756) at a regular interval which has been a beacon of natural science research till date. Even before that the college had great touch with this journal when it was published not under the banner of Darjeeling Government College. It has long been one of the most influential and cited journal in the field of natural science also. In addition, The “Journal of Bengal Natural History” maintained the highest level of ethical integrity, ensuring consistency and scientific rigor in each of its research articles. My desire is also for the “Journal of Bengal Natural History” to continue to excel and insightfully build for the future to provide the greatest venue for sharing outstanding science, immediately adjoining without intervening space for ***NORTH FACE*** as well.

It is no secret that the landscape of scholarly publishing is quickly changing. Across disciplines, new demands and expectations from both authors and readers have encouraged shifting perspectives among editors and publishers. My primary goal as editor-in-chief is to ensure that ***NORTH FACE*** remains flexible in attending to the rapidly shifting scientific communication landscape, while also maintaining and intensifying the high standards of academic excellence. By steadily introducing initiatives to the editorial and review processes, I believe ***NORTH FACE*** will further develop as a flagship for communicating research bit by bit, all while successfully meeting the evolving needs of its readers.

As always, my top priority, and that of our renowned editorial board, is ensuring that ***NORTH FACE*** continues each year to publish novel research that advance our field. I am dedicated to leading the board's mission in providing authors with a productive, fair, and timely review experience. Authors are invited to submit their work at any time throughout the year and should carefully review the submission criteria and requirements. The journal attempts to maintain rigorous peer-reviewed standards for further betterment of the articles. Our expedited blind review process allows for a thorough analysis by expert peer-reviewers within a time line to beef up the academic publication.

I sincerely hope that all readers will eagerly access ***NORTH FACE***, as both submitters and readers, for the insightful and stimulating academic environment that will shape our future and lead the way to extraordinary breakthroughs.

Wish a promising future to ***NORTH FACE***.

Thanking you all,

**Dr. Projjwal Chandra Lama**

## Editorial

The North Face is a multidisciplinary, multilingual, peer reviewed, refereed journal, published by Darjeeling Government College. The content of the North Face provides an in-depth coverage of the fundamental concepts related to higher studies of science, humanities, commerce and economics with numerous illustrations and exhibits.

The initial topics of this journal provide a broad overview of current science researches and its functioning like, advancement of quantum mechanics tunneling and duality aspect in recent time; current concepts of gastric cancers; what kind of treasures can be found in an ant nest; importance of mycorrhizal fungal association; current hallmarks of Alzheimer's disease; how an established carnivore can be converted into an omnivore; ecological role and importance of dung beetle; as well as, how modern-day fruit bat population fighting with global warming for their existence. The subsequent topics discuss modern trends of humanities and the manipulation of this area of arts subjects by various critical angles like, current status of Nepali drama; and aspect of recognizing cinema as a powerful ideological tool, Feminist Film Theory seeks to deconstruct filmic texts to expose the blatant androcentric worldview. The journal also delves into the current mode of business and commerce with special emphasis on how small enterprises play a catalytic role in the development process of the Indian economy; and non-performing assets issues and how adversely it impact the Indian national economy.

Owing to its comprehensive coverage, this journal would be very much useful to academicians, postgraduate students of science, humanities and commerce and economics and also researchers.

In this regard, we are very much thankful to the authors for imparting their knowledge through value based articles in this journal. We are also grateful to the honorary reviewing editors who have spent their valuable time to evaluate the articles. Their cooperation is highly solicited also in future for the betterment of the journal. In addition to all the foregoing, we are showing our gratitude to **Dr. Sumana Saha, erstwhile Coordinator, IQAC** of this college, who has contributed a lump sum amount towards financing the cost of publication by foregoing her remuneration for the entire period, entitled to get as Coordinator, IQAC.

**Editors**

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## **The Idea of the ‘Male Gaze’ As a Tool of Feminist Film Theory**

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### **ABSTRACT:**

Recognizing cinema as a powerful ideological tool, Feminist Film Theory seeks to deconstruct filmic texts to expose the blatant andro-centric worldview that is deeply entrenched in them. Contemporary filmic texts make use of the mechanisms of voyeurism and fetishisms – inherent in narrative styles, camera angles and visual forms – to invite the audience to share and ‘participate in’ the ‘male gaze’ of the hero, that seeks to establish the woman and her body as a passive erotic object for the gaze of the audience. This article seeks to explore the idea of the ‘male gaze’ as conceptualized by Laura Mulvey, and show how this concept is useful in understanding and exposing the perpetuation of female stereotypes and construction of the female gender commensurate with patriarchal value systems, in films.

**Keywords:** Cinema, Feminist, Film Theory, Male, Hollywood, Gender

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Cinema is one of the most powerful contemporary tools available to an ideology for propagating itself – at once unobtrusive and deeply insidious and all-pervasive. Feminist Film Theory seeks to deconstruct filmic texts to expose the andro-centric worldview that is deeply entrenched in them. The idea of “The Male Gaze” is a useful tool that Feminist critics have used to understand and reveal the extent to which filmic texts are structured according to patriarchal ideological positions and male fantasies of voyeurism, subsequently representing



women in a manner that reduce women to the position of an objectified 'Other', denying women existence for themselves. "Woman appears to man solely as 'a sexual being', not as an autonomous entity: she is defined and differentiated with reference to man and not he with reference to her; she is the incidental, the inessential as opposed to the essential. He is the Subject, he is the Absolute – she is the 'Other'". (De Beauvoir, 2011, p. 26) Therefore, a feminist "reading" of filmic text becomes imperative to counter the perpetuation of female stereotypes and the construction of the female gender commensurate with patriarchal value-systems.

In her article "Visual Pleasure and Narrative Cinema", written in 1973 and published in *Screen* in 1975, Laura Mulvey argued that the controlling gaze in cinema is always male. Spectators are encouraged to identify with the look of the male hero and make the heroine a passive object of erotic spectacle. Mulvey's concept of the 'male gaze' subsequently became the main talking point of feminist film debate – which might be defined as "the political campaign involving women's struggle to gain control over their own bodies and how they are represented" (Chaudhuri, 2006, p. 33); the notion of woman as passive spectacle; and the passivity of spectators. The underlying idea in the works of Feminist Film Critics is that one can break through the alienating spectacle or façade to women's 'reality' hidden behind it, what keeps the spectacle in place and what puts women in positions of enforced passivity and moreover makes men and women accept this as natural and inevitable. In other words, it not only seeks to offer a description of ideology but account for how ideology is produced and perpetuated. Mulvey's theoretical work makes this possible, drawing on Althusserian Marxism, semiotics, and – most of all – psychoanalysis. While semiotics led to a way of understanding how images work as signs, psychoanalysis, Mulvey believed, was best placed to unlock "the mechanics of popular mythology and its raw materials." (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 13) Reflecting on her work fifteen years later, she writes: "Psychoanalytic theory provided . . . the ability to see through the surface of cultural phenomena as though with intellectual X-ray eyes. The images and received ideas of run of the mill sexism were transformed into a series of clues for deciphering a nether world, seething with displaced drives and misrecognised desire". (Mulvey, *Introduction*, 1989, p. xiv) In "Visual Pleasure and Narrative Cinema", she remarks on the "beauty" of psychoanalysis in the way it renders the frustration women experience under 'the phallogocentric order'. (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 15) The essay is heavily inflected by the theories of Jacques Lacan, who famously stated that "the unconscious is structured like a language". (Lacan, 1988) Mulvey sets out to uncover the

ways in which 'the unconscious of patriarchal society has structured film form'. (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 14) This political use of psychoanalysis enables her to turn her focus from the mere description of woman as spectacle to the male psyche whose needs the spectacle serves.

The 'magic' of Hollywood, argues Mulvey, lies in its "skilled and satisfying manipulation of visual pleasure." (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 16) Central to this is what Freud, in his 'Three Essays on the Theory of Sexuality', called 'scopophilia' or "pleasure in looking". (Freud, 1991, p. 70) In its active aspect, scopophilia involves taking people as objects for sexual stimulation through sight, "subjecting them to a controlling and curious gaze." (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 16) An extreme example of this is a Peeping Tom, whose sexual satisfaction is wholly dependent on this activity. Although mainstream cinema is obviously designed for public exhibition, Mulvey suggests that it effectively positions its spectators as Peeping Toms: the darkened auditorium gives each spectator the illusion of being a privileged voyeur, peeping in on a private world, separate from the rest of the audience. Mulvey adds that cinema also develops scopophilia 'in its narcissistic aspect', exploiting the viewer's desire to identify with a human face and form that they recognize as being similar to their own. However, this identification is based on an imaginary misrecognition because the mirror presents an ideal ego – perfect, complete, and in control. It is not difficult to connect this to cinema. Sitting in the auditorium, fascinated by the images on the screen, the spectator's awareness of themselves as a separate entity temporarily dissolves – they forget who they are and the time and space they inhabit. The spectator identifies with the glamorous stars on the screen – ego ideals who 'act out a complex process of likeness and difference'. Mulvey argues that there are two forms of looking involved in the spectator's relationship with the screen. One is active scopophilia, which uses another person as an erotic object and in which the subject's identity is different from and distanced from the object on the screen. In narrative cinema, woman plays a 'traditional exhibitionistic role' – her body is held up as a passive erotic object for the gaze of male spectators, so that they can project their fantasies on to her. She connotes "to-be-looked-at-ness." (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 19) The men on screen, on the other hand, are agents of the look, with whom spectators identify to enjoy vicarious control and possession of the woman. We can see, in almost any classic Hollywood film, that the heroine is an object to be looked at: she is filmed in soft focus, "coded for strong visual and erotic impact." (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989, p. 19) Narrative cinema, then, is not unlike other visual forms that display women as sexual objects, such as

pin-ups or striptease. But what distinguishes cinema from other forms of female sexual display is that it incorporates permutations of the look into its very structure, predetermining how the woman is to be looked at, and thus placing all spectators in the ‘masculinized’ position of looking at her. Mulvey observes that there are three sets of looks involved in cinema: (1) the camera’s look at the pro-filmic reality, (2) the audience’s look at the final film product, and (3) the characters’ looks at each other. The conventions of narrative cinema strive to make the audience forget the camera and the fact that they are watching a film. They work to deny both (1) and (2) in favour of (3) – all in the interests of creating a ‘convincing’ illusion of a world where the male protagonist acts as the spectator’s surrogate. In the narrative structure, too, the male drives the story forward, while the female has a passive role, linked to her status as spectacle. As well as identifying with ‘the active power’ of the hero’s gaze at the woman, the spectator acquires the illusion of ordering and controlling the narrative themselves. The voyeuristic strategy is typical of film noir, a genre known for its sexually alluring but deadly femmes fatales. In the process of investigating an intrigue or murder, the hero (usually a detective) ends up investigating her. The hero, who thus represents the Law, brings her crimes to light but, at an unconscious level, it is really the problem of her sexuality that is being resolved. Through his voyeuristic and sadistic control over her, the hero reaffirms his own mastery (and, by proxy, the male spectator’s). The *Maltese Falcon* (1941) exemplifies this: it ends with the femme fatale being arrested, prison bar-like shadows cast across her as she is taken away in a caged lift. On the cinema screen itself, the woman is presented as an erotic spectacle. The camera isolates fragments of her body (face, breasts, and legs) in close-ups. The use of such close-ups for the heroine stresses that, unlike the hero, she is valued above all for what her appearance connotes, for her beauty and sexual desirability. One is unlikely to find similar sorts of shots of the male hero, unless the shots concern narrative events. The close-ups of parts of the female body, on the other hand, have the quality of a ‘cut-out or icon’, temporarily halting the flow of the narrative to invite erotic contemplation and shattering the illusion of depth rather than enforcing verisimilitude. The glamour of the star is emphasized and becomes pleasurable in itself, “a perfect streamlined image of femininity”. (Mulvey, *Fetishism and Curiosity*, 1996, p. 8) Mulvey argues that Sternberg’s films represent a special instance in narrative cinema as they bypass the male protagonist’s controlling gaze altogether, facilitating a ‘direct rapport’ between the image and the spectator. The woman in these films, she writes, is ‘a perfect product, whose body, stylised and fragmented by close-ups, is the content of the film and the direct recipient of the spectator’s look’.

These tendencies are markedly pronounced in classic Hollywood films. The title sequence of the classic spaghetti-Western *High Noon* (1952) is an illustration of the cinematic techniques enumerated above. The film opens with a medium shot of a male – dressed in the typical denim and cowboy hat – who looks out into the field. The camera then focuses on an eye-line shot, where a horseman is seen riding up. Another cowboy arrives, the two men converse briefly, and then the sequence comes to an end. Throughout the sequence, the male characters on screen – there are, admittedly, no women characters in the sequence – are shot from the camera positioned below the waistline, which gives the impression of increased stature and power. The contrast becomes all the more evident when this sequence is contrasted with the opening sequence of the film *Sin City* (2005), based on the graphic novels of Frank Miller. The film opens with the camera looking down upon a terrace on top of a building. A woman appears, and the spectator can only see her bare back. Even though the entire sequence is filmed in black and white, the lips and gown of the woman are bright red, which serves to emphasize her “otherness”, her role as a passive erotic object and the sense of the spectator of the woman as the object. This impression is further heightened throughout the sequence with the help of “over-the-shoulder-shots” and camera angles.

Mulvey emphasizes the need for women to understand the mechanisms of voyeurism and fetishism that underlie the patriarchal unconscious of narrative film. At the time of writing ‘Visual Pleasure and Narrative Cinema’, her aims were iconoclastic: to break the codes and destroy narrative pleasure. At the end of her essay she calls for filmmakers to “free the look of the camera into its materiality in time and space and the look of the audience into dialectics and passionate detachment.” (Mulvey, *Visual Pleasure and Narrative Cinema*, 1989 a, p. 26) At that point, she imagined a feminist cinema along the lines of radical modernist practice, with its strategies of self-reflexivity, disruption, and defamiliarization. While it might be argued that such a cinema is extant and gradually coming of age, the all-encompassing reach of mainstream Hollywood films makes the task of feminist filmmakers and critics that much more onerous.

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## यात्रा साहित्य - सिद्धान्तको खोजीमा

नवीन पौड्याल

पेदोङ सरकारी महाविद्यालय, पेदोङ

### १. विषय प्रवेश -

मानिसले विभिन्न प्रकारले ज्ञान हासिल गर्दछ। यात्राबाट पनि मान्छेले अनेक ज्ञान हासिल गर्दछ। यात्रा ज्ञानको अजस्रोत हो। मान्छेको स्वभाव नै यात्रातर्फ उन्मुख हुन्छ। मान्छे स्वभावले नै घुमक्कड हुन्छ। भ्रमणशीलता मान्छेको नैसर्गिक प्रवृत्ति हो। मान्छेले आफ्नो यात्राको शुरुआत आदिमकालमा आफु ओडारबाट निस्किएदेखि नै गरेको हो। मान्छे घुम्दै घुम्दै संसारभरि आफ्नो आधिपत्य जमाइसकेर अब अन्तरीक्ष यात्रातिर पनि लम्किसकेको छ।

यात्रा विवरण त प्रायः सबै साहित्यिक विधाका ग्रन्थहरूमा पाइन्छन्। जोनाथन स्विफ्टको गुलिभरको यात्रा पनि यस किसिमको रम्याख्यान हो। होमरको ओडिससीमा नायक ओडेसीको यात्रा विवरण, दाँतेको डिभाइन कमेडी आदि ग्रन्थहरू यात्रा विवरण पाइन्छ। संस्कृतका धेरै काव्यमा पनि यात्रा वर्णन पाइन्छन्। रामायणको 'यण' को शाब्दिक अर्थ नै रामको यात्रा भन्ने बुझिन्छ। महाभारतमा पनि अर्जुनको भ्रमणको वर्णन पाइन्छ। कालीदासको मेघदूतमा पनि पाइन्छ।

यात्रा साहित्यलाई सर्वप्रथम चिनीयाँ भाषामा travel Record Literature (youji wenxue) भनिन्थ्यो। यस्तो साहित्य आख्यानत्मक, गद्यात्मक, निबन्धात्मक, र दैनन्दिनी शैलीमा लेखिने गरिन्थ्यो। सर्वप्रथम यो यात्रासंस्मरण ग्रीसमा दोस्रो शताब्दीमा पाउसनाज (Pausanias) अभिलेखमा पाइएको थियो। चीनमा सोङ्ग वंशमा ट्राभेल रेकर्ड लिटरेचर भनियो।

### २. परिभाषा

साहित्यका विभिन्न विधामध्ये निबन्ध एउटा प्रमुख विधाका रूपमा रहेको छ। निबन्धभित्र पनि अनेक उपविधाहरू रहेका हुन्छन्। त्यस्ता उपविधाहरूमा प्रबन्ध, लेख, जीवनी, आत्मजीवनी, संस्मरण, यात्रा संस्मरण, रूबन्ध आदिका रूपमा भेद गरिएको पाइन्छ। यसमध्ये यात्रासित सम्बन्धित संस्मरण नै यात्रासंस्मरण हो। नेपाली साहित्यमा यस उपविधालाई यात्रावृत्तान्त, यात्रावृत्त, यात्राविवरण, यात्रानिबन्ध, भ्रमणवृत्तान्त, यात्रासाहित्य, भ्रमणसाहित्य, नियात्रा आदि अनेक नाम प्रचलित छन्। हिन्दी साहित्यमा पनि यात्रासाहित्य, यात्रावृत्तान्त, यात्रानिबन्ध, यात्रासंस्मरण आदि प्रयुक्त भएका छन्। अङ्ग्रेजी साहित्यमा पनि ट्राभल लिटरेचर, ट्राभल एकाउन्ट, ट्रेभल मेमोर्सका साथै ट्राभल र मोनोलोग शब्दहरूको योगबाट ट्राभलग शब्द प्रचलित देखिन्छ। अङ्ग्रेजीमा यात्रा विवरणलाई जनाउने अन्य केही शब्दावलीहरूमा आउटडोर लिटरेचर, एक्लोरेसनमा, एडभेन्चरस लिटरेचर, माउन्टेन लिचरेचर ट्राभल गाइड बुक जस्ता शब्दहरू पनि प्रयुक्त छन्। हिन्दीको नियात्राकार राहुल सांकृत्यायनले घुमक्कडी साहित्य पनि भनेका छन्। यसरी नै नेपालीमा पनि निबन्ध र यात्राको योगबाट नियात्रा शब्द निर्मित भएको छ।<sup>1</sup> नियात्रा साहित्यिक विधाविशेषबोधक निबन्ध शब्दबाट नि उपसर्ग झिकी यात्रा शब्दमा लगाएर यात्रानिबन्धको अर्थमा नवनिर्माण गरिएको शब्द हो। निजात्मक अनुभूति निबन्ध तत्वको रूपमा आएजस्तै नियात्रा मा पनि निजात्मक अनुभूतिको उपस्थिति रहनु आवश्यक हुन्छ। यस अर्थबाट हेर्दा सबै यात्रावर्णन रचना नियात्रा होइनन् र मानवीय संवेदनायुक्त आत्मपरक शैलीका यात्रावर्णन नियात्रा हुन् भन्ने बुझिन्छ।<sup>2</sup>

बालकृष्ण पोखरेलले निबन्धको वर्गीकरण गर्ने क्रममा दुईवटा वर्गीकरण गरेका छन् - प्रबन्ध र जमर्का। प्रबन्धका विभिन्न उपभेदमध्ये यात्रा विवरण (Travel Account) लाई राखेका छन् भने जमर्का (निजात्मक) का चारवटा भेदमध्ये नियात्रालाई एउटा अर्कै उपभेदका रूपमा राखेका छन्। यस हिसाबले हेर्दा बालकृष्ण पोखरेलले यात्रा-विवरण र नियात्रालाई अलगअलग अर्थ र उपविधाका रूपमा प्रस्तुत गरेका छन्। उनका अनुसार यात्रा गर्दा सामान्य विवरण यात्रा विवरण हो भने त्यही यात्रा विवरण गर्दा लेखकले निजी रङ्गमा रंगाएर साहित्यिक अभिव्यक्ति दिँदा नियात्राको जन्म हुन्छ। यात्रा विवरण वा भ्रमण संस्मरणमा आधारित भएरै नियात्रा लेखिन्छ। यसको सत्य विषयवस्तुले नै यसलाई कथा हुनुबाट जोगाएर नियात्राको रूप लिन्छ। हिन्दी साहित्यमा पनि यात्रासाहित्य शब्द बढी उपयुक्त हुन्छ। यसका दशवटा श्रेष्ठ कृतिहरूमा दत्तात्रेय बालकृष्ण काका कालेलकरको 'यात्रा का आनन्द', राहुल सांकृत्यायन 'किन्नर देश में', अज्ञेयको 'अरे यायावर

<sup>1</sup> निर्मोही व्यास, *नियात्रा साहित्यको सैद्धान्तिक परिचय*, वैजयन्ती, स्वदेश यात्रा अङ्क, अङ्क ६, २०६७, पृष्ठ ७०।

<sup>2</sup> ओमी शर्मा, *नियात्रासाहित्य यात्रावृत्तान्त र यात्रासंस्मरण*, वैजयन्ती अङ्क-६, २०६७, पृष्ठ ६९।

रहेगा याद', फणीश्वरनाथ रेणूको 'ऋणजल धनजल', मोहन राकेशको 'आखिरी चट्टान तक', निर्मल वरमाको 'चीँडो पर चाँदनी', कृष्णनाथको 'स्पीति में वारिश', राम कुमारको 'युरोप के स्केच', कृष्णा सोवतीको 'बुद्ध का कमण्डल लद्दाख' र अमृतलाल बेगडको 'तीरे तीरे नर्मदा' हुन्।

बालकृष्ण पोखरेलको यात्रा साहित्यसम्बन्धी दुई किसिमका वर्गीकरणलाई अघि बढाउँदै यात्रा वर्णन र नियामा गरी दुई वटा वर्गीकरण गरेका छन्। यात्रावर्णन, यात्राविवरण, यात्रावृत्तान्त र यात्रासंस्मरणमा यात्राका विषयवस्तु र घटनाक्रमहरूको उपस्थिति भए पनि निजात्मक अनुभव र अनुभूतिका प्रसङ्गहरू कि हुँदै हुँदैनन् कि ज्यादै कम हुन्छन्। तर घटनाक्रमसँगसँगै लेखका अनुभव, अनुभूति र विचारहरूको मनोरम प्रस्तुतिका शीप र शैलीको त्यो रचना यात्रा वर्णन-विवरण- संस्मरण हो या नियामा हो भन्ने निर्धारण गर्छ। **नेपाली बृहत् शब्दकोश**मा नियामाको अर्थ दुईवटा दिइएको छ- १. यात्रा निबन्धको औपन्यासिक वा उपाख्यानात्मक रूप। २. यात्रा वर्णनबारे कथात्मक शैलीमा लेखिएको निबन्ध।<sup>३</sup> यसबाट नियामा निबन्धकै उपविधाका रूपमा देखाइएको बुझिन्छ। नियामा शब्द नेपालीमा मात्र प्रयोग देखिन्छ। यसको सैद्धान्तिक रूपमा न्वारान गर्ने बालकृष्ण पोखरेल हुन्। उनले वि. सं. २०२५ मा प्रकाशित तारानाथ शर्माको **बेलायततिर बरालिँदा** पुस्तकको भूमिकामा सर्वप्रथम यस शब्दको प्रयोग गरेका गरेका थिए।<sup>४</sup> त्यसपछि वि. सं. २०४० मा **बृहत् नेपाली शब्दकोश**मा यस शब्दले प्रविष्टि पायो। त्यसपछि भने नेपालीमा यही शब्दले मान्यता व्यापकता पायो र यो शब्द सामान्य उपविधाको रूपमा चलनचल्तीमा आयो।

नियामा शब्दको व्युत्पत्ति यात्रा निबन्धबाट भएको हो। निबन्ध शब्दबाट नि उपसर्ग झिकी यात्रा शब्द लगाएर यात्रानिबन्धको अर्थमा नवनिर्माण गरिएको शब्द हो। निबन्धमा झैं यसमा पनि निजात्मक अनुभूतिको उपस्थिति रहनु आवश्यक हुन्छ। यात्रा विवरण दिँदैजाँदा आफ्ना रागात्मक अनुभूति र संवेदनालाई समेत अभिव्यक्ति दिँदै आत्मपरक शैलीमा चमत्कारितासहित लेखिने नियामा हो। 'कुनै सृजनशील यात्रीले यात्राका क्रममा देखे-भोगेका विविध परिदृश्य, घटना प्रसङ्ग र सङ्गालेका अनुभवलाई निजात्मक रङ्गले रंगाएर भावना र कल्पनाको यथोचित समन्वयका साथ मनोहारी शैलीमा आत्मपरक ढङ्गबाट लिपिबद्ध गरेको यथार्थपरक गद्यकृति नै नियामासाहित्य हो।'<sup>५</sup> यात्रा विवरण जति सबै नियामा हुँदैन। निरस तवरले वस्तुनिष्ठ वर्णनबाट

<sup>३</sup> बृहद् नेपाली शब्दकोश, काठमाडौं, नेप्रप्र, २०६८

<sup>४</sup> बालकृष्ण पोखरेल, *यी नियामाबारे*, बेलायततिर बरालिँदा, तानासर्मा,(भूमिका), पृष्ठ ख)

<sup>५</sup> निर्मोही व्यास, *नियामा-साहित्यको सैद्धान्तिक परिचय*, वैजयन्ती, अङ्क ७, वर्ष १, २०६७, असार-साउन, पृष्ठ ७२)



साहित्यिकता नआए नियात्रा हुँदैन। बालकृष्ण पोखरेलले यात्रासाहित्यलाई यात्रा विवरण र नियात्रा गरी दुई भेद गरेका छन्। उनका अनुसार सत्यको निस्तो वर्णन छ भने लेख मात्र हुन्छ औ रमरमको आनन्दबाट मुछिएको चाँहि नियात्रा हुन्छ। नियात्रालाई उद्देश्य जे भए पनि गौण हुनुपर्छ। यात्रालेख पशुपतिको जात्रा हो भने नियात्रा चाँहि सिद्धाको व्यापार हो।<sup>6</sup> यात्राकारको स्वयंको उपस्थिति, यात्राकारको निजात्मक अनुभूति, रोचकता, चित्रात्मकता, यात्राको पश्चकालिक प्रस्तुति<sup>7</sup> अनुभूतिका साथै आत्मीयता, स्वच्छन्दता, अनोपचारिकता, कल्पनाप्रवणता, हार्दिकता र भावनाको उच्छलन जस्ता गुणको समन्विति यसको निबन्धात्मक स्वरूपसित सम्बन्धित भावात्मक पक्ष हो भने यात्राका क्रममा लेखक यात्रीसित सम्बन्धित हुन आउने स्थलहरू, व्यक्तिहरू, विविध दृष्यावली र घटना-प्रसङ्ग अनुभवात्मक पक्ष हुन्।<sup>8</sup> आदि यसका स्वरूप र विशेषता हुन्। नियात्रासित संस्मरणको पनि सहसम्बन्ध हुन्छ। यद्यपि आफ्नो बाल्यकालको सम्झना वा कसैसितको सम्झनामा लेखिने संस्मरण र यात्रामा देखिएको र अनुभूत गरिएको सम्झनामा लेखिएको नियात्रा हो। यसर्थ, यात्रासित सम्बन्धित संस्मरण मात्र नियात्रा हो। नियात्रा साहित्यलाई पनि क. वर्णनात्मक-विवरणात्मक ख. आख्यानात्मकता, ग. पत्रात्मक, घ. दैनिकी लेखन, ङ. संस्मरणात्मकता, च. निबन्धात्मक गरी छवटा उपभेद गर्न सकिने ठाउँ छ।<sup>9</sup>

### ३. नियात्रा- निबन्ध कि अन्य विधा?-

नियात्रालाई विधा खुट्याउने क्रममा दुईवटा मत देखा पर्छन्- पहिलो मतमा यो निबन्ध विधाअन्तर्गत पर्दछ। अर्को मतमा यसलाई स्वतन्त्र विधाका रूपमा मानिन्छ। नियात्रा शब्दको नि उपसर्गलाई निबन्ध माने पनि निजात्मकता माने पनि केही अध्येताहरूले यसलाई निबन्ध विधाभित्र नराखी अन्य विधाका रूपमा उभ्याएका छन्। अघिल्लो मतका केही पक्षधरमा बालकृष्ण पोखरेल, डा लक्ष्मणप्रसाद गौतम, राजेन्द्र सुवेदी, बालकृष्ण पोखरेल, तारानाथ शर्मा आदि हुन्। डा बासुदेव त्रिपाठीका अनुसार स्वयम् आफ्नै अनुभवमा आत्मकथा, दैनिकी, संस्मरण र यात्रावृत्तान्त आधारित हुन्छन् र यी विधामा केन्द्रविन्दु स्वयम् नै हुन्छ। यति हुँदाहुँदै पनि आत्मकथा र दैनिकी मूलतः स्वयम्मा केन्द्रित रहन्छन् भने संस्मरण र यात्रावृत्तान्त चाँहि विन्दुमा आफु रहँदारहँदै पनि वर्ण्य विषयका मूलमा अर्कै व्यक्ति वा वस्तु तथा विषयलाई अँगाल्दै आत्मपरकताबाट प्रशस्त

<sup>6</sup> बालकृष्ण पोखरेल, पूर्ववत्, पृष्ठ ६

<sup>7</sup> ओमी शर्मा, *नियात्रासाहित्य- यात्रावृत्तान्त र यात्रासंस्मरण*, वैजयन्ती, वर्ष १ अङ्क ६), पृष्ठ ६९

<sup>8</sup> निर्मोही व्यास, *यात्रा साहित्यको विधागत स्वरूप र विशेषता*, रत्न बृहत् नेपाली समालोचना (सैद्धान्तिक खण्ड), काठमाडौं, रत्न पुस्तक भण्डार, २०६८, पृष्ठ ४१३।

<sup>9</sup> निर्मोही व्यास, *पूर्ववत्*, पृष्ठ ४१२-४१३।

फैलिई वस्तुपरकतातिर जान सक्छ। उनका अनुसार अन्यविधाको यात्रासाहित्य आख्यानात्मकतामा पर्दछ।<sup>10</sup> डा. घनश्याम नेपालले नियात्रालाई एक स्वतन्त्र उपविधाका रूपमा मानेका छन्।<sup>11</sup> यस्तै गरी निर्मोही व्यासले पनि यसलाई एक स्वतन्त्र विधा वा नव अन्यविधाका रूपमा लिएका छन्। निबन्धचाँहि यात्रासाहित्यको पूर्वज विधा हो।<sup>12</sup> निर्मोही व्यासका विचारअनुसारको निबन्ध र यात्रा साहित्यका बिच मुख्य भिन्नता यसरी देखाउन सकिन्छ-

	निबन्ध	नियात्रा
१.	मूलतः स्थितिशील लेखन	पूर्णतः गतिशील लेखन
२.	संस्मरणतत्त्व अनुभूतिका रूपमा मात्र	संस्मरणतत्त्व अनिवार्य रूपमा
३.	स्वकेन्द्री लेखन	आत्मपरक हुँदाहुँदै परकेन्द्री लेखन
४.	स्वच्छता, कल्पनाप्रवणता, चिन्तनगतता	स्थानीयता, तथ्यात्मकता, विवरणात्मकता, गतिशीलता, निजात्मकता, चित्रात्मकता।
५.	वैचारिकताको प्राधान्य	विवरणात्मकता, सूचनात्मकता।

समग्रमा नियात्राका लक्षण, विशेषता र स्वरूपलाई यसरी केलाउन सकिन्छ-

१. नियात्रामा यात्रावृत्तान्तका स्मृतिबिम्बहरूको प्रयोग र त्यस्ता स्मृतिबिम्बहरूलाई कल्पनाको रङ्गले रङ्गाइएको हुन्छ।
२. नियात्रामा लेखकीय स्वको आत्मप्रकटीकरण हुन्छ र यसमा वैयक्तिकताको समेत प्रशस्त उपयोग हुन्छ।
३. वर्णनको मनोहारिता, रोचकता र कुतूहलता हुन्छ।
४. यो प्रथम पुरुष दृष्टिकोणमा नै लेखिन्छ।
५. यसमा कोरा वृत्तान्त वा वर्णनात्मकता हुनुहुँदैन।

<sup>10</sup> बासुदेव त्रिपाठी, साहित्य-सिद्धान्त, शोध तथा सृजनविधि, काठमाडौं, पाठ्य सामग्री पसल, २०६६, पृष्ठ २०३।

<sup>11</sup> डा घनश्याम नेपाल, नेपाली साहित्यको परिचात्मक इतिहास, सिलगढी: एकता बुक हाउस प्रा लि.२००९, पृष्ठ २६०

<sup>12</sup> निर्मोही व्यास, यात्रासाहित्यको विधागत स्वरूप र विशेषता, रत्न बृहत् नेपाली समालोचना (सैद्धान्तिक), पृष्ठ ४१२.

६. सूचनात्मकता, निजात्मकता र चिन्तनशीलता हुन्छ। # (प्रमोद प्रधान, नेपाली निबन्धको इतिहास, काठमाडौं, रत्न पुस्तक भण्डार, २०६६, पृष्ठ २१७)।

७. नियात्रामा लेखकले उसको गद्यमा काव्यिकता ल्याउनु पर्छ।

८. लेखकले यात्रा वर्णन गर्दा आफुलाई कवि, दार्शनिक, अन्वेषक आदिको रूपमा समाहार गर्नुपर्छ।<sup>13</sup>

भ्रमण साहित्य भन्दैमा जम्मै नियात्रा हुँदैनन्। नियात्रामा आत्मीयता, हार्दिकता, रागात्मकता, कल्पनाप्रवणता, चित्रात्मकता र रमणीयता आदि गुणको अनिवार्य रूपमा समन्वित हुनुपर्छ। अतः नियात्रा यात्राकालीन दैनिक टिपोट र संस्मरणको रागात्मक लेखन हो। यसमा स्थानविशेषको सामाजिक, सांस्कृतिक, रीतिरिवाज, इतिहास, भूगोल, प्राकृतिक सौन्दर्य, स्थानीय इतिवृत्त आदि झल्काइएको हुन्छ। भ्रमण गरिएको ठाउँको सामान्य विवरण भए यात्रानिबन्ध, यात्राविवरण, यात्रावृत्तान्त हुन्छ भने यात्रावर्णनमा लेखकले आफ्ना अनुभव र अनुभूतिलाई कलात्मक ढङ्गले प्रस्तुत गरेमा त्यो नियात्रा कहलाउँछ।<sup>14</sup> अर्थात् विशिष्ट किसिमको भए मात्र नियात्रा हुन्छ। लेखकले सोझो तरिकाले कहिले हिँडियो, एकलै कि अरु कसैसँग डुलियो, केमा चडेर गइयो, कहाँ बसियो, के खाइयो, कहिले फर्किइयो आदिजस्ता कुरा मात्र वर्णन गरियो भने नियात्रा हुँदैन। विषयवस्तुका साथसाथै भावना पनि हुनुपर्छ। नियात्रा पढ्दा पाठक पनि बनोस् घुमक्कड र अभिन्न मित्र अनि लेखकसँग हिँडिरहोस् यात्राको आनन्द लिँदै र साथमा ज्ञान बटुल्दै।<sup>15</sup> यस यात्रा संस्मरणसित सम्बन्धित अन्य शब्दहरू पनि प्रयुक्त छन्। तीर्थाटन, देशाटन, पर्यटन, भ्रमण आदि पनि प्रयुक्त छन्। कोही तीर्थको उद्देश्य लिएर घुम्ने तीर्थाटन, कोही सामान्य रूपमा देश-विदेश भ्रमण गर्नु देशाटन हुन्छ। पर्यटन भनेको कुनै एउटा ठाउँको कुनै आकर्षणले देश-विदेशका मानिसहरू घुम्ने काम गर्नु हो। विद्यार्थीहरूको कुनै सर्वेक्षण र अन्वेषणात्मक उद्देश्य लिएर घुम्ने गरेको पनि देखिन्छ। यस्तोमा शैक्षिक भ्रमण हुन्छ। पैदलै हिँडेर कुनै दुरी तय गर्नु पदयात्रा हो। कुनै राजनयिक व्यक्तिले विदेशतिर गएर अन्य देशका राजनयिक व्यक्तिहरूसित सम्पर्क गर्ने उद्देश्य लिएको छ भने कुटनैतिक यात्रा आदि पनि प्रयुक्त हुन्छन्। कोही मानिस आफ्नो शौकका रूपमा मात्र पनि यात्रा गर्छन्। यसर्थ, धार्मिक यात्रा, स्वदेश यात्रा, विदेश यात्रा, कुटनैतिक यात्रा, तीर्थ यात्रा आदिसित सम्बन्धित सबै खाले लेखन यात्रा संस्मरण हुन्। यात्रासंस्मरणका तत्व - यात्रासंस्मरण लेखनअन्तर्गत नियात्रालाई एउटा उपविधाका रूपमा लिँदा यसका केही तत्व केलाउन सकिन्छ। यसका केही तत्वहरूमा<sup>16</sup>-

<sup>13</sup> जयनारायण लुङ्गटेल, *निबन्धनिकुञ्ज*, गुवाहाटी, अनुराग प्रकाशन, २०११, पृष्ठ ३५।

<sup>14</sup> प्रमोद प्रधान, *नेपाली निबन्धको इतिहास*, काठमाडौं, रत्न पुस्तक भण्डार, २०६६, पृष्ठ २१८

<sup>15</sup> जयनारायण लुङ्गटेल, *पूर्ववत्*, पृष्ठ ३५।

<sup>16</sup> ओमी शर्मा, *पूर्ववत्*, पृष्ठ ७०

**३.१. यात्राकारको स्वयम् उपस्थिति-** यसमा यात्राकार स्वयम् उपस्थितिबिना यात्रा लेखनको कुनै औचित्य हुँदैन। यात्रा गर्ने एकजना र वर्णन गर्ने अर्को भएमा त्यो यात्रा बन्नसक्दैन।

**३.२. यात्राकारको निजात्मक अनुभूति-** यसमा यात्राकारको निजात्मक अनुभूतिको लेखन हुन्छ। यात्राकारको मनस्थितिमा उपस्थित भएका बिम्ब, प्रतीक आदि यात्राका क्रममा टिपिएका कतिपय टिपोटहरू समुचित व्यवस्थापन गरी निजात्मक भावपरक रूपले लेखिएको रचना यात्रा हो।

**३.३. यात्राको परवर्ती प्रस्तुति-** यात्रामा यात्राकारले यात्रा गरिसकेपछिको प्रस्तुति हुन्छ। त्यसैले यसमा यात्राको स्मृतितत्त्व प्रधान रूपले उपस्थित हुन्छ।

**३.४. चित्रात्मकता -** यात्रामा पाठकले यात्राकार सँगसँगै यात्रा गरेको अनुभूति गर्दछ। कुनै स्थान अथवा यात्राकारले कुनै कोहीको वर्णन गर्दा पाठकका आँखामा त्यसको चित्र उपस्थित भएमा यात्राकार सफल भएको मानिन्छ।

**३.५. रोचकता -** लेखन रोचक बनाउन यात्राकारले कतै आख्यान, कतै हास्यको सहायता लिन सक्छ। यस किसिमको प्रयोगले यात्रा रोचक बन्न सक्छ।

**३.६. गतिशीलता-** यस्तो साहित्यमा सोझै मुख्य कुरालाई लिएर लेखक अघि बढेको हुन्छ। यात्राका क्रममा एकपछि एक साक्षात्कृत हुँदै जाने स्थान, दृश्य, समाज, संस्कृति, जनजीवन एवं घटनाप्रसङ्गप्रति यात्रीको कौतूहल यात्राको गतिसँगै क्रमिक रूपमा अघि बढ्दै जान्छ र यात्राअवधिभरि त्यो क्रम जारी रहन्छ र यात्राको अन्त्यसँगै त्यसको अन्त्य हुन्छ।

**३.७. तथ्यात्मकता-** यात्रा गरिएका ठाउँहरूमा पाइने विविध विषयगत तथ्य र जानकारीहरूको औचित्यपूर्ण उल्लेख पनि यात्रासाहित्यका निम्ति अपरिहार्य हुन्छ। यसको प्रस्तुति सामान्य तथ्य वर्णनका रूपमा नभएर रोचक र साहित्यिक मूल्यवत्ता हुनुपर्छ।

### **३. नेपाली साहित्यमा यात्रा -**

नेपाली साहित्यमा यात्रा साहित्य निकै विकसित बनेको छ। आजभन्दा लगभग ५०० वर्ष अघिको 'राजा गगनीराजको यात्रा' देखि आजसम्ममा नेपाली यात्रासाहित्यले धेरै घुम्ती, मोड-उपमोड पार गर्दै विकसित हुँदैआएको देखिन्छ। यदि हामीमाझबाट घुम्न जानेमध्ये दश प्रतिशत व्यक्तिहरूले आफुले गरेको यात्रा वर्णन लिखित रूपमा प्रकाशित गरे भने पनि नेपाली यात्रा अझ निकै विकसित हुने थियो। यद्यपि नेपाली यात्रा साहित्य त्यति अविकसित र कमजोर भने अवश्य छैन, विकसित र सम्पन्न छ। सं १९१०मा प्रकाशित जङ्गबहादुरको बेलायत यात्रा नेपाली यात्रासाहित्यको कोसे-ढुङ्गो सावित भएको छ भने शेरसिंह राना, लैनसिंह

बाइदेल, तारानाथ शर्मा, केदारमणि आदी, प्रकाश ए राज, घनश्याम राजकर्णिकार, सलोन कार्थक, जय छाड्डा आदि नेपाली नियात्रा साहित्यका विशिष्ट साधक हुन्।

नेपाली नियात्रा साहित्यको कालविभाजन गर्ने क्रममा प्रमोद प्रधानले तीन चरणमा विभाजन गरेका छन्-<sup>17</sup>

क) प्रारम्भिक वा पहिलो चरण (वि सं १९१० भन्दाअघिसम्म)

ख) विकासशील वा दोस्रो चरण (वि सं १९१०- वि सं २००९ सम्म)

ग) आधुनिक वा तेस्रो चरण (वि सं २०१० देखि यता)

यसमा रहेको प्रथम चरणमा यस्तो साहित्य त्यति नदेखिएको भए तापनि राजा गगनीराजको यात्रालाई मूल आधार मानिएको छ। यसका लेखक करवीर रावल थिए र यसको रचनाकाल सं १५५० हो। यस कृतिको खोजिपत्ता लगाउने पूर्णप्रकाश यात्री हुन्।<sup>18</sup> यस चरणमा नियात्रा साहित्यको पृष्ठभूमि मानिन्छ। वि सं १९१० को जङ्गबहादुरको बेलायत यात्रादेखि दोस्रो चरण मानिन्छ। यस चरणका नियात्रा कृतिहरूमा राजकीय कामका लागि शासकहरूले यात्रा गर्ने गरेका र यात्रा प्रसङ्गसँग सम्बन्धित विषय र अनुभवलाई यात्रा दलका कर्मचारीहरूलाई लेखाउने गरेको पाइन्छ। शासकहरूबाहेक विदेशी सेनामा काम गर्न गएका र तीर्थयात्राका क्रममा भएका भ्रमणहरूका आधारमा लेखिएका केही कृति देखा परेका छन्। यस चरणका केही नियात्रापरक कृतिहरूमा **जङ्गबहादुरको बेलायत यात्रा** (सं १९१०), चिरञ्जीवी पौड्यालको **आफ्नु कथा**, रणसूर लिम्बूको **बर्माको सम्झना**, राममणि आदीको **यात्रासंस्मरण**, पतञ्जली गजुरेलको **तीर्थावली**, शेरसिंह रानाको **मेरो लण्डन राजतिलक यात्रा** इत्यादि। यस कालमा अनेक कृति र लेख नियात्रा साहित्यको रूपमा देखा परेका छन्। यस चरणमा नै नेपाली नियात्रा साहित्य लेखनका क्रममा धेरै विकास गरेको, साहित्यिक मूल्यवत्ता ग्रहण गरेको, सौन्दर्ययुक्त लेखन र लेखकको भावावेग र अनुभूतिका कारण पनि उल्लेखनीय हुनपुगेको छ। तेस्रो चरणको शुरुवात् वि सं २०१० को लैनसिंह बाडदेलले प्रगतिमा धारावहिक रूपमा प्रकाशित युरोप भ्रमणको वृत्तान्तबाट भएको हो। तिनै लेखहरूको संकलन **युरोपको चिठी** (वि सं २०१४) हो। स्पेनको सम्झना र रोमको एउटा फूल प्यारिसको एउटा काँडा उनका उत्कृष्ट यात्रा संस्मरणसाहित्य हुन्। यस चरणमा धेरै भ्रमणपरक लेख र लेखकहरू देखा परेका छन्। नेपाली नियात्रा साहित्यलाई उत्कर्षमा पुऱ्याउने श्रेय तारानाथ शर्मालाई जान्छ। उनको **बेलायततिर बरालिँदा** (वि सं

<sup>17</sup> प्रमोद प्रधान, *नेपाली निबन्धको इतिहास*, काठमाडौं, रत्न पुस्तक भण्डार, २०६६, पृष्ठ २२०।

<sup>18</sup> प्रमोद प्रधान, *पूर्ववत्*, पृष्ठ २१९।

२०२६) पुस्तकले मदन पुरस्कार सम्म पाएको हो। उनीबाहेक केदारमणि आ. दी, यादव खरेल, रमेश विकल, मञ्जुल, घनश्याम राजकर्णिकार, गंगा उप्रेती, गोविन्द वर्तमान, जय छाडछा, पूर्णप्रकाश यात्री, युवराज नयाँघरे, विजय चालिसे, इशान गौतम बुलु मुकारूड, प्रतीक ढकाल, निर्मोही व्यास, मधुवन पौडेल, शैलेन्द्र साकार, डा साफल्य अमात्य, गोरखबहादुर सिंह, मोहन चापागाईँ, तेजप्रकाश श्रेष्ठ, भीष्म उप्रेती, रोशन थापा नीरव, हरि थापा, तुलसीहरि कोइराला, प्रकाश सायमी, रामप्रसाद पन्त, मणि लोहनी, कृष्णराज खनाल, राजेश लामिछाने, कुलचन्द्र वाग्ले, केदार भट्टराई, श्रीओम श्रेष्ठ रोदन, कुमारप्रसाद कोइराला, गोरखबहादुर सिंह, सुलोचना मानन्धर, डा मथुरा केसी, शारदा अधिकारी, अकिञ्चन शर्मा आदि अनेकौं नाम आउँदछन्। यस चरणमा नियात्रा साहित्यले पूर्ण विकास गरेको छ।

केदारमणि आदीलाई नेपाली यात्रासाहित्यका शिरोमणि मानिन्छ। उनका जम्मा सोह्रवटा नियात्राका ग्रन्थ प्रकाशित छन्। उनका स्वदेश र विदेश भ्रमणलाई पुस्तकाकार रूप दिएर नेपाली यात्रा संस्मरण साहित्यलाई निकै सम्पन्न तुल्याएका छन्। यसैगरी नेपाली साहित्यमा यात्राको विवरण काव्यात्मक रूपमा पनि नपाइने होइन। जस्तै खेमनाथ शर्मा पौडेलको **अध्ययन भ्रमण** (२०५२), कृष्णप्रसाद जवालीको **मानस-सरोवरका छालहरू** (२०५५), प्रहलाद पोखरेलको **गोसाईँकुण्ड** (२०५६) रमेश खकुरेलको **खासा हलासा**(२०५८), विष्णुगोपाल रिसालको **अमेरिकालाई हेर्दा** (२०६२), गणेशकुमार पौडेलको **बङ्गलादेशको सफर**(२०५७, गद्यकवितामा), पं. शिवराज बराल - **काशीयात्रा** आदि हुन्। यद्यपि यस्ता पद्यमा लेखिएका यात्रासाहित्यलाई नियात्रा मान्न सकिन्न। (प्रमोद प्रधान : पृष्ठ २०६६) नेपाली साहित्यमा केही विशिष्ट नियात्रापरक कृतिहरूमा तारानाथ शर्माको बेलायततिर बरालिँदा (२०२६), देवीचन्द्र श्रेष्ठको काठमाडौँबाहिर (२०२८) र हुम्ला बोल्छ मानसरोवरमा (२०३७), जनकलाल शर्माको कौतुकमय डोल्पो (२०३१), सात सूर्य एक फन्को, कुमार घिसिङको दुनघाटी-नालापानी, योगी नरहरिनाथको हाम्रो देश दर्शन (२०३२), सूर्यबहादुर सेनको देशदर्शन (२०३३), यादव खरेलको समुद्रपारि, सलोन कार्थकका विदेशतिर रिडदै जाँदा, पदयात्रा गाउँको फन्को विदेशको, विश्व-एउटा पल्लो गाउँ, जय छाडछाको चाँप गुराँसको मुन्तिर, पूर्णप्रकाश नेपाल यात्रीका सेतीको नालीबेली, जगदीश घिमिरे थ्याडबुचे यात्रा, एम बी प्रधानको मनका लहर र रहरहरू (सन् २०१०), गोविन्द गिरी प्रेरणाको फेरो (२०५३) आदि मुख्य हुन्।

#### ४. भारतमा नेपाली यात्रासाहित्यको स्थितिको अध्ययन - भारतमा नेपाली नियात्रा साहित्य-

भारतीय नेपाली नियात्रा साहित्यको परिप्रेक्ष्यमा भाक्सूका शेरसिंह रानामगरको सन् १९१३ मा प्रकाशित 'मेरो लंदन राजतिलक यात्रा' पहिलो प्रकाशित पुस्तक हो। उनी १४ गोर्खा राइफल्समा हुँदा सन् १९११ मा पञ्चम जर्जको राजतिलक समारोहमा ब्रिटिस सरकारको निम्तोमा लन्डन पुगेका थिए। त्यहाँको हरेक दृश्य-परिदृश्यको विवरण डायरीमा टिपेर पुस्तकाकार रूप दिएका हुन्। उनले उक्त पुस्तकमा लन्डनको प्रकृति र जलवायु, अँग्रेजहरूको रहन-सहन, आर्थिक उन्नति र अन्य गतिविधिको विवरण प्रस्तुत गरेका छन्।<sup>19</sup>

यसपछि पादरी गंगाप्रसाद प्रधानको सम्पादनमा निस्कने मासिक **गोर्खा खबर कागज**को सन् १९३० सालको जनवरी, फरवरी र मार्च महिनाका तीन अङ्कमा ARP को नाममा एउटा यात्रापरक लेख **स्कटलेण्डको बखान** धारावाहिक रूपमा प्रकाशित भएको देखिन्छ। पादरी गंगाप्रसाद प्रधानबारे शोध-अध्ययन गर्ने सलोन कार्थकका अनुसार उक्त ARP ले सम्पादक प्रधानलाई आफ्नो स्कटलेण्ड यात्रा गोर्खा खबर कागजमा प्रकाशित गरिदिनु होला भनी निवेदन-पत्र लेखेको छ। यसमा सन् १९२९ सालमा दार्जीलिङदेखि कलकत्ता, त्यहाँबाट बम्बई अनि जोर्डन देश हुँदै, स्वेस केनल पार गर्दै स्कटल्याण्ड पुगेको र त्यहाँ पनि विभिन्न दृश्य-दृश्यावलीको वर्णन गरिएको छ। ती ARP अरु कोही नभएर पादरी गंगाप्रसाद प्रधानकै सुपुत्री एग्नेस राजमति प्रधान हुनसक्छ। यद्यपि उक्त प्रेषण-पत्रमा सम्पादकलाई परिवारको सदस्य नभइ तटस्थ रूपमा लेखिएको पाइन्छ। यस हिसाबले नेपाली साहित्यमा नै प्रथम नारी यात्रासाहित्यकार राजमति प्रधान हुन्।<sup>20</sup> फूटकर रूपमा यात्रा विवरण त धेरै छन् तर पुस्तकाकार रूपमा पनि केही थोरै संख्यामा छन्। थाहा पाइएअनुसार अहिलेसम्म भारतबाट प्रकाशित नेपाली नियात्राका कृतिकार र पुस्तकाकार कृतिहरूको सूची यसरी बनाउन सकिन्छ-

१. शेरसिंह राना- **मेरो लंदन राजतिलक यात्रा** (१९१३)।

२. दिलबहादुर नेवार- **दक्षिण भारत यात्रा**,<sup>21</sup> **यात्रा संकलन**, **यात्रा संस्मरण**।

३. लैनसिंह बाडदेल- **यूरोपको चिड्डी वि. सं. २०१४**), **स्पेनको सम्झना** (वि.सं.२०२०), **रोमको एउटा फुल र प्यारिसको एउटा काँडा** (वि.सं.२०१७)

४. पं. शिवराज बराल - **काशीयात्रा काव्य** (अनुमानित सन् १९६०)

५. पारसमणि प्रधान- **मेरो काठमाडौँ यात्रा** (१९७५)।

<sup>19</sup> गुप्त प्रधान, *धूमिल पृष्ठहरू*, दार्जीलिङ, गामा प्रकाशन, २००९, दो.सं, पृष्ठ--)

<sup>20</sup> सलोन कार्थक, *विश्व एउटा पल्लो गाउँ*, कालिम्पोङ : सरिकार प्रकाशन, २०१३, पृष्ठ १६०-१६२।

<sup>21</sup> लुईटेल, पूर्ववत्, पृष्ठ ३५।

६. डा शान्ति छेत्री- मेरो यूरोप यात्रा,(सन् १९९५) र अरब सागरको सूर्यास्त (सन् १९८६)।
७. सलोन कार्थक- समुद्रवारि- समुद्रपारि (सम्पादित), विदेशतिर रिङ्दै जाँदा, पदयात्रा गाउँको फन्को विदेशको, विश्व एउटा पल्लो गाउँ (२०१३)।
८. दुर्गाप्रसाद श्रेष्ठ- देश देशान्तर यात्रा वृत्तान्त। (हिन्दीमा)
९. पवन चामलिङ- यूरोप भ्रमण – केही संस्मरण
१०. कुमार घिसिङ- दूनघाटी नालापानी (१९८२)
११. कविता सुब्बाको शैक्षिक भ्रमण एवम् संस्मरण,
१२. डा गीता उपाध्याय- मन्दाकिनी र अलकानन्दको तीरैतीर केदारबद्रीसम्म (सं २०६०)
१३. प्रद्युम्न श्रेष्ठ- मेरा केही यात्रा संस्मरणहरू (१९९४)
१४. जगन्नाथ उपाध्याय र लावन्यदेवी- बृटेनमा केही दिन।
१५. चूडामणि उपाध्याय भट्टराई- क्यालिफोर्निया- अमेरिकाको झ्याल।
१६. सानु लामा- आँगन परतिर,
१७. के पी मल्ल- गाउँ घर - देश परदेश, र यात्रा- घर आँगनदेखि परदेशसम्म (२०१३)।
१८. एम पथिक- पथिकका पाइलाहरू (२०१३)
१९. जयनारायण लुङ्गटेल- दुबइ हुँदै अमेरिकासम्म (२००१) र छाँगादेखि गुफासम्म (२०११)
२०. एम. बी प्रधान- मनका लहर र रहरहरू (२०११)
२१. प्रजापति शास्त्री- तीर्थदर्शन (२००४)।
२२. भवानी उपाध्याय- मेरो बेलायत यात्रा ।
२३. चन्द्रकुमार राई- भ्रमण र जीवन यात्रा ।



२४. शिव शास्त्री- काशी दर्शन।

२५. डी पी जोशी - मेरो युरोप यात्रा।

२६. खड्गबहादुर छेत्री (के बी छेत्री) -

२७. चूडामणि दाहाल- मेरो युरोप यात्रा (२०१४)

यीबाहेक विभिन्न पत्र-पत्रिकामा फूटकर रूपमा यात्रावृत्तान्त प्रकाशित पाइन्छन्। भारती, दियालो, स्पन्दन, पूर्व किरण, हाम्रो ध्वनि आदि पत्रिकामा लेखका रूपमा यात्रा संस्मरण प्रकाशित छन्। भारती पत्रिकामा प्रकाशित त्यस्ता केही यात्रापरक लेखहरूमा मनकुमारी थापाका 'मेरो स्कटल्याण्ड यात्रा' (सन् १९५३), 'प्यारिसको झलक' (१९५४), राधिका रायाको मेरो पहिलो समुद्र यात्रा (१९५५), मधुमालती प्रधानको मेरो बनारस यात्रा (१९५५) उल्लेखनीय छन्। अन्य पत्रिकामा प्रकाशित केही लेखहरूमा लख्खीदेवी सुन्दासको 'मेरो काबुल यात्रा' (दियालो), लक्ष्मण नेपालका उन्नयन पत्रिकामा प्रकाशित तीनवटा लेखहरू 'भुवनेश्वरको यात्रा' (सं २०५९), 'सिक्किमदेखि कन्याकुमारीसम्म' (सं २०६०) र 'कलकताबाट बरहमपुर' (२०६१)। शान्ति थापाको 'ब्रह्मपुत्रदेखि गोदावरीसम्म' (सन् २००८, हाम्रो ध्वनि), विन्द्या सुब्बाको 'अरब सागरको किनारमा' (दियालो), रुद्रराज मास्केको 'मेरो पश्चिमाञ्चल यात्रा र अन्य' महानन्द पौड्यालका 'मेरो ठिमिले आसाम यात्रा' र 'मेरो पहिलो काठमाडौं यात्रा' दुर्गाप्रसाद जोशीका नियात्रात्मक लेख इत्यादि।

#### ५. नेपाली यात्रासाहित्यको मूल्याङ्कन र उपसंहार -

नेपाली साहित्यमा यात्रा संस्मरण निकै विकसित उपविधाको रूपमा फस्टिदै गएको अवस्था छ। यसलाई नियात्रा, यात्रासाहित्य, यात्रा संस्मरण, यात्रा विवरण जस्ता विविध शब्दहरूमध्ये नियात्रा वा यात्रा यात्रासाहित्य नै शब्द नै प्रयुक्त छ। यद्यपि जे शब्द प्रयुक्त भए तापनि संस्मरणभित्र नै पर्दछ। नेपाली साहित्यमा यात्रासाहित्य निकै अघि बढेको छ। नेपाली साहित्यमा यसको पूर्वसङ्केत राजा गगनीराजको यात्रा देखि लिएर अनेक पुस्तकहरू प्रकाशित हुँदै आएका देखिन्छन्। केदारमणि दिक्षितलाई यात्राशिरोमणि साहित्यका रूपमा चिनिन्छ। उनले नै सबैभन्दा बढी यात्रासंस्मरणका पुस्तक प्रकाशित गरेका छन्। यसपछि तारानाथ शर्मा, जय छाड्छा, इशान् गौतम, प्रकाश ए राज र यता भारतका सलोन कार्थक, एम बी प्रधान यस दिशातर्फ अग्र पंक्तिमा छन्। नेपाली साहित्यमा यात्रासाहित्यको उत्कर्षता दिने श्रेय तारानाथ शर्मालाई जान्छ।

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## **Trends and Analysis of Non Performing Asset of Banking Sector in India During 2001-2012**

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### **ABSTRACT:**

Non-performing Assets do not just reflect badly in a bank's account books, they adversely impact the national economy as well. Here, we try to analyze the trends of Non-Performing Assets of Public sector banks, Private Sector Banks and Foreign Banks during the period from 2000-01 to 2011-12. Also we try to find out the impact of Non-Performing Assets of different banks on their profitability. The percentage of total non-performing assets has reduced mainly due to reduction in the percentage of sub-standard assets, doubtful assets and loss assets and also due to increase in the percentage of standard assets which is beneficial for their profitability. Our regression analysis in case of all scheduled commercial banks shows that non-performing assets significantly influence the profitability at 10% level but there exists a negative relation between Non-Performing Asset and profitability of Scheduled Commercial Banks although we have overall significance. If Non-Performing Assets are not properly managed it can cause financial and economic degradation which in turn hampers the investment which is crucial for the profitability of all Banks.

**Key words:** Non-performing Assets, Standard Assets, Loss Assets, Commercial Bank

### **BACKGROND:**

Banking sector plays a vital role as an integral part of the financial system for the development of an economy, for any nation. Banks act as a development agency and are the source of hope and aspirations of the masses. A major threat to banking sector is prevalent of non-performing assets. 'A high level Non-Performing Assets suggest high probability of a large number of credit defaults that affect the profitability and the net worth of banks and also erode the value of the asset' (Ms. Asha Singh, 2013). In fact, Non-Performing Assets have a classification used by financial institutions that refer to those loan on which interest amount

or installment remain unpaid for a certain period of time. Once the borrower has failed to pay interest or principal amount for ninety days the loan is considered to be a non-performing asset. Reserve Bank of India classifies Non-performing Assets in the following four categories:

- **Standard Assets:** Standard assets means the asset in which, no default in repayment of principal or payment of interest is perceived and which does not disclose any problem nor carry more than a normal risk attached to the business. Standard Assets is not a Non-performing asset in real sense.
- **Sub-standard Assets:** A sub-standard assets is one which has been classified as Non-performing Asset for a period not exceeding twelve months.
- **Doubtful Assets:** A Doubtful Asset is one which has remained unpaid Non-performing Asset for a period exceeding twelve months.
- **Loss Assets:** Where loss has been identified by the bank, internal or external auditor or central bank inspectors. But the amount has not been written off, wholly or partly.

Non-performing Assets are of two types:

- **Gross Non-performing Assets:** Gross Non-performing assets are the sum total of all loan assets that are classified as non-performing assets as per Reserve Bank of India guidelines as on Balance Sheet date. It consists of all the non-standard assets like as sub-standard assets, doubtful assets and loss assets. It is calculated with the help of following ratio:

Gross Non-performing Assets Ratio= Gross Non-performing Assets/Gross Advances

- **Net Non-performing Assets:** Net Non-performing Assets are those types in which the bank has deducted the provisions regarding Non-performing assets. Net Non-performing Asset shows the actual burden of banks. Since in India, bank Balance Sheet contain a huge amount of Non-performing Assets and the process of recovery and write off of loans is very time consuming, the banker have to make certain provision against the Non-performing Assets according to the central bank guidelines. It can be calculated by following:

$$\text{Net Non-performing Assets} = \frac{\text{Gross non-performing assets} - \text{provisions}}{\text{Gross Advances} - \text{Provisions}}$$

In India, Non-performing Assets are one of the major concerns and hence for the entire economy. The problem of Non-performing Assets in the Indian Banking System is one of the foremost problems that have seriously affected the banking industry. It has reduced the profitability of banks and shaken the confidence of investors, depositors and lenders.

In the year 1991, financial reforms were undertaken by the Government of India, as a result of which prudential norms were introduced by the Reserve Bank of India to address the credit monitoring process being adopted and pursued by the banks and financial institutions. Thereafter, for the purpose of strengthening further the recovery of dues by banks and financial institutions. Government of India tries to control or bring stability in the recovery of debts due to banks and Financial Institution act, 1993 and The Securitization and Reconstruction of Financial Assets and Enforcements of Security Interest Act, 2002 (T. R. Radhakrishnan). With a view to move towards international best practices and to ensure greater transparency, it had been decided to adopt the 'ninety days' overdue norm for identification of Non-performing Assets, from the year ending 31<sup>st</sup> March, 2004. Accordingly, with effect from 31<sup>st</sup> March, 2004, Non-performing Assets is a loan or an advance where, interest and installment of principal remain overdue for a period more than ninety days in respect of term loans, overdraft/cash credit and bills and in case of agricultural loan where, interest and installment of principal remains overdue for two harvest seasons but for a period not exceeding two and half years.

Non-performing Assets result from Bad loans or defaults made by the customers in the payment of principal and interest amount. These loans can occur due to usual banking operations/ bad lending practices, a banking crisis, overhand component(due to environmental reasons, business cycle, etc), incremental component (due to internal bank management , like credit policy, terms of credit etc.)

## **NEED/ JUSTIFICATION:**

Non-performing Assets do not just reflect badly in a bank's account books, they adversely impact the national economy as well. The problems/repercussions caused by increasing Non-performing Assets in bank's accounts books are as follows:

- Depositors do not get rightful returns and many times may lose un-insured deposits. Banks may begin charging higher interest rates on some products to compensate non-performing loan losses.
- Bank shareholders are adversely affected
- Bad loans imply redirecting of funds from goods projects to bad ones as a result of which economy suffers
- When bank do not get loan from repayment or interest payments, liquidity problems may ensure.

Non-performing Assets result in decreased profitability, reduction in capital assets and lending limits, increase in loan loss reserves and bring unwanted attention from Government regulations.

With this backdrop it is necessary to review the position of non-performing assets of scheduled commercial banks in India, for which this paper tries to focus on the non-performing assets of different public sector banks, private sector banks and foreign banks and the impact on their profitability in recent years according to the availability of concerned data.

## **REVIEW OF LITERATURE:**

**B.Selvarajan and Dr. G. Vadivalagan** in their paper “A Study on Management of Non Performing Assets in Priority Sector Reference to Indian Bank and Public Sector Banks (PSBs)”-(2013), viewed that in India bad debts problem was not taken seriously. Subsequently, by following the recommendations of Narsimham Committee and Verma Committee, few steps had taken by the Reserve Bank of India in order to solve the problem of old Non-performing Assets in Balance Sheet of banks. It continues to be expressed from every corner that there has rarely been any systematic evaluation of the best way of tackling the problem. There seems to be no unanimity in the proper policies to be followed in resolving this problem.

**Ms. Asha Singh** in her paper “Performance of Non-Performing Assets (NPAs) in Indian Commercial Banks”- (2013), viewed that Non-performing Assets in India are one of the major concerns for banks. This is so because, Non-performing Assets is the best indicator for health of the banking industry as well as primary indicator of credit risk. Non-performing Assets are an inevitable burden on the banking industry. Hence, the success of the bank

depends upon the methods of managing Non-performing Assets. The Public Sector Banks have shown very good performance over the Private Sector Banks as far as the financial operations are concerned. The Indian banking sector is facing a serious problem of Non-performing Assets. The magnitude of Non-performing Assets is comparatively higher in Public Sector Banks than Private Sector Banks. Thus, in order to improve the efficiency and profitability of banks, the Non-performing Assets need to be reduced and controlled.

**C. S. Balasubramaniam** in his paper “Non-performing Assets And Profitability of Commercial Banks in India: Assessment And Emerging Issues” (2001) attempts to analyze the trend of the banks in recent decade since 2000. This paper assumes significance with the recent proposal by Reserve Bank of India to introduce Basel III norms in the banking sector from January 2013. Basel III framework of guidelines formulated by bank for International Settlements (BIS) in consultation with Central Bank operating in a number of countries all over the world expect the participating banks in their respective economies to be following healthy financial and operational management policies. His paper brings out discussion on the concept of Non-performing Assets in the context of identification and control procedures, impact of Non-performing Assets on profitability and financial soundness of banks in general, trend analysis of Non-performing Assets followed by a series of in depth analyses on the high level of borrowings from banking sector indicating a buildup of sectoral credit booms in general and also raising concerns about financial performance and operations of the borrowers, impact of restructuring of advances by banks on the basis of asset classification and certain issues and perspectives on the performance of banking sector and financial stability of the economy emerge as conclusion.

**Rajiv Ranjan and Sarat Chandra Dhal** in their paper “Non-Performing Loans and Terms of Credit of Public Sector Banks in India: An Empirical Assessment”- (2003) explores an empirical approach to the analysis of commercial banks’ non-performing loans in the Indian context. The empirical analysis evaluates as to how banks’ non-performing loans are influenced by three major set of economic and financial factors, i.e., terms of credit, bank size induced risk preferences and macroeconomic shocks. The empirical results from panel regression models suggest that terms of credit variables have significant effect on the banks’ non-performing assets in the presence of bank size induced risk preferences and macroeconomic shocks.’ Moreover, alternative measures of bank size could give rise to

differential impact on banks' non-performing loans. In regards to terms of credit variables, changes in the cost of credit in terms of expectation of higher interest rate induce rise in Non-Performing Assets. On the other hand, factors like horizon of maturity of credit, better credit culture, favorable macroeconomic and business conditions lead to lowering of Non-Performing Assets. Business cycle may have differential implications adducing to differential response of borrowers and lenders.

**Our paper** differs from the works mentioned in the literature review in the sense , here, we try to analyze the trends of Non-Performing Assets of Public sector banks, Private Sector Banks and Foreign Banks during the period from 2000-01 to 2011-12. Also we try to find out the impact of Non-Performing Assets of different banks on their profitability.

## **OBJECTIVE:**

With the backdrops that have been discussed in the introduction part of the study, this paper tries to:

- Analyze the trends of Non-Performing Assets in Indian Public Sector, Private Sector and Foreign Banks in the post reform period.
- Discuss the impact of Non-Performing Assets of commercial banks on their profitability, loans advanced and the important variables.

## **METHODOLOGY:**

We have collected the secondary data regarding Non-Performing Asset of all Scheduled Commercial Banks and also computed the ratio of sub-standard asset, doubtful asset and loss asset as a ratio of total advance. Then we have analysed the trend of Non-Performing Assets of all categories of Scheduled Commercial Banks using the averages. Thus we have used one statistical tool i.e., Measures of Central Tendency to analyze the data for the concerned period. We have also used Co-efficient of variation to measure the consistency or performance of different Non-Performing Assets over the years for all Scheduled Commercial Banks. We use the formula

$$\text{Co-efficient of Variation} = \text{Standard Deviation} / \text{Mean} \times 100$$



In order to have the idea of impact of Non-Performing Asset on the profitability of different categories of Scheduled Commercial Banks (Public Sector, Private Sector and Foreign Banks). We use the linear regression model which is of the form

$$Y_i = \alpha + \beta x_i + u_i$$

Where  $Y_i$  is profit of banks in  $i^{\text{th}}$  year

$x_i$  is Non-Performing Asset to Total Advance for  $i^{\text{th}}$  year

$u_i$  is disturbance term which incorporate other factors influencing profitability of banks that have not been captured in the model.

We infer the regression result on the basis of t-value, corresponding p-value and also value of  $R^2$  and F statistics.

In this study section-1 provides introduction of the subject which contains the background of the study, need/justification of the study, review of literature, objectives and methodology of the study.

Section -2 provides the conceptual framework of the subject and national and international scenario.

Section -3 provides the presentation and analysis of data, its interpretation, statistical results and findings of the study.

Section -4 provides concluding observations and recommendations.

## **Section-2**

### **CONCEPT:**

Performance in terms of profitability is a benchmark for any business enterprise including the banking industry. However, increasing Non-Performing Assets have a direct impact on profitability of banks as legally banks are not allowed to book income on such accounts and at the same time banks are forced to make provisions on such assets as per the Reserve bank of India guidelines on performing Asset means an assets on account of borrower, which has been classified by the banks or financial institutions as sun-standard asset, doubtful or loss asset.

A reduction in the total gross and net Non-Performing Assets in Indian financial system indicates a significant improvement in management of Non-Performing Assets. Suit filed and Bureau of Industrial Finance and Reconstruction are the two most common approaches to resolution of Non-Performing Assets in public sector banks. Data available on resolution strategies adopted by public sector banks suggest that Compromise settlement schemes with borrowers are found to be more effective than legal measures.

Generally it has been observed that genuine borrower face the difficulties in raising funds from banks due to mounting Non-Performing Assets. Either the bank is reluctant in providing the requisite funds to the genuine borrowers or if the funds are provided, they come at a very high cost to compensate the lender's losses caused due to high level of Non-Performing Assets. Therefore, the corporate prefer to raise funds through commercial papers where the interest rate on working capital charged by banks is higher. Through the enactment of the Securitizations and Reconstruction of Financial Assets and Enforcement of Security Interest Act, 2002, banks can issue notices to the defaulters to pay up the dues and the borrowers will have to clear their dues within sixty days. Once the borrower receives a notice from the concerned bank and the financial institution, the secured assets mentioned in the notice cannot be sold or transferred without the consent of the lenders.

Non-Performing Asset means booking of money in terms of bad asset, which occurred due to wrong choice of client. Because of the money getting blocked the profitability of bank decreases not only by the amount of non-performing asset but non-performing asset lead to opportunity cost also as that much of profit invested in some return earning project. So Non-Performing Asset does not affect current profit but also future stream of profit, which may lead to loss of some long term beneficial opportunity. Another impact of reduction in profitability is low return on investment, which adversely affect current earning of bank.

Money is getting blocked, decreased profit lead to lack of enough cash at hand which lead to borrowing money for shortest period of time which lead to additional cost to the company. Difficulty in operating the functions of bank is another cause of non-performing asset due to lack of money Time and efforts of management in handling and managing non-performing asset would have diverted to some fruitful activities, which would have given good returns. If a bank is facing a problem of non-performing asset, then it adversely affects the value of bank in terms of market for credit. It will lose its goodwill and brand image and credit which have negative impact to the people who are putting in their money in the banks.

## International Scenario

A country with a large population or Gross Domestic Product may have large advances and, in turn, larger Non-Performing Asst as well. Thus, apart from the absolute value, it is also important to look at what proportion of the total loan has become non-performing. The N levels of various countries as a percentage of their total loans are presented in Table 2. One interesting feature revealed by T able2 is that the Non-Performing Asset/Non-Performing Loan as a percent age of the total loans has been declining for almost all countries over the years. The average Non-Performing Asset as a percentage of total loans across the countries was around 11.89 per cent in 2001, which declined to around 6.44 per cent in 2005.

### Bank Non-Performing Loans to Total Loans

<b>Countries</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>
Australia	0.60	0.40	0.30	0.20	0.20
Bangladesh	31.50	28.00	22.10	17.60	15.30
Brazil	5.60	4.80	4.80	3.80	4.40
Canada	1.50	1.60	1.20	0.70	0.50
Chile	1.60	1.80	1.60	1.20	0.90
China	29.80	25.60	20.10	15.60	10.50
Egypt	16.90	20.20	24.20	16.30	25.00
France	5.00	5.00	4.80	4.20	3.50
Germany	4.60	5.00	5.30	5.10	4.80
Hong Kong	6.50	5.00	3.90	2.30	1.50
Indonesia	31.90	24.00	19.40	14.20	15.60
Japan	8.40	7.20	5.20	2.90	1.80
Korea	3.40	2.40	2.60	1.90	1.20
Malaysia	17.80	15.80	13.90	11.80	9.90
Mexico	5.10	4.60	3.20	2.50	1.80
Pakistan	23.40	21.80	17.00	11.60	10.60
Philippines	27.70	26.50	26.10	24.70	20.00
Russia	6.20	5.60	5.00	3.80	3.20
Singapore	8.00	7.70	6.70	5.00	3.80
Sri Lanka	15.30	15.30	13.70	9.10	9.60

Switzerland	2.30	1.90	1.40	0.90	0.50
Thailand	11.50	16.50	13.50	11.80	11.10
Turkey	29.30	17.60	11.50	6.00	4.80
United Kingdom	2.60	2.60	2.50	1.90	1.00

Source: World Development Report, 2006, RBI notes, various years

This shows that the quality of bank assets has been improving across countries over the years. This could be the result of the stringent regulations prescribed by the BASEL norms (Sen and Ghosh, 2005). Examining the countries in terms of Non-Performing Asset as a percentage of total loans, we observed that for 16 countries Non-Performing Asset percentage was below 10 per cent and for around 5 countries It was between 10-20 per cent; for another 5 countries the Non-Performing Asset percentage was rather high at more than 20 per cent. Australia has the lowest Non-Performing Asset to total loan ratio, which is just 0.34 per cent whereas the Philippines tops the list with 25 per cent. India is in the 11th highest position with around 8.6 percent. One interesting observation is that most of the countries that fall under the higher 'Non-Performing Loan/Total Loan' ratio category are in the Asian region. Out of 10 countries that have a ratio above 10 per cent, eight are Asian. The improvement in the quality of the assets across countries is also shown by the fact that in 2001, the Non-Performing Asset/Total Loan ratio of 11 countries was above 10 per cent and by 2005 this number reduced to 7.

### Section-3

#### ANALYSIS AND FINDINGS:

First we analyze the non-performing asset of all commercial banks in terms of total non-performing asset, standard asset, sub-standard asset and loss asset. In table 1 we see that in 2000-01 percentage of total non-performing asset to total advance is highest i.e. 11.45% after that it gradually started decreasing and comes to 7.19% in 2003-04. But thereafter, percentage of non-performing assets started decreasing at a fast rate and reduced to 2.35% in the year 2010-11.

**Table- I : Non-Performing Assets of all Commercial Banks**

Year	Total Advance	Total NPA	%of NPA to Advance	%of standard assets to total advance	% of sub standard assets to total advances	%of doubtful assets to total advances	%of loss assets to total advances
2001	558679	63963	11.45	88.55	3.26	6.76	1.43
2002	680925	70953	10.42	89.58	3.14	6.05	1.23
2003	778040	68780	8.84	91.16	2.58	5.11	1.15
2004	902027	64898	7.19	92.81	2.33	4.02	0.85
2005	1124926	58023	5.16	94.84	1.25	3.29	0.62
2006	1473527	51242	3.48	96.52	1.00	2.03	0.45
2007	1893513	50296	2.66	97.34	1.05	1.29	0.31
2008	2331676	55842	2.39	97.61	1.12	1.05	0.23
2009	2793133	68220	2.44	97.56	1.29	0.96	0
2010	3271361	81813	2.50	97.50	1.26	0.99	0.24
2011	4011435	94084	2.35	97.65	0.994	1.12	0.24
<b>Average</b>			<b>5.35</b>	<b>94.65</b>	<b>1.75</b>	<b>2.97</b>	<b>0.61</b>

**Source: Handbook of Statistics on Indian Economy (RBI), various years, Author's Calculation**

In case of standard asset, the percentage of standard asset to total advance is showing increasing trend from 88.55% in 2000-01 to 97.65% in 2010-11. In case of sub-standard asset, the percentage of sub-standard asset to total advance in 2000-01 is 3.26% which is highest and thereafter, it starts showing decreasing trend 2.33% in 2003-2004 and it reduced to 0.994% in 2010-11. In case of doubtful assets, the percentage of doubtful asset to total advance is highest in 2000-01 i.e. 6.76% and starts decreasing to 4.02% in 2003-04 and gradually reduced to 1.12% in 2010-11. In case of loss assets, the percentage of loss asset to total advance is highest in 2000-01 i.e. 1.43% which reduced to 0.85% in 2003-04 and in 2008-09 it reduced to 0% but thereafter increased to 0.24% in 2010-11.

So we can see that total non-performing asset has shown a decreasing trend during the concerned period showing that some effective measures have been adopted by all the commercial banks as a result of which there is such a drastic fall in percentage of non-performing assets. This decreasing trend has been shown by all the different types of non-performing assets such as sub-standard assets, doubtful assets, loss assets except standard assets but as we know from the definition of standard asset that it is not a non-performing

asset in real sense. So, increasing trend in percentage of standard assets to total advance shows positive impact on the profitability of commercial banks.

The co-efficient of variation of a series of observation measures the consistency or performances of the series. We have found out the Co-efficient of Variation of Non-performing Assets in terms of total Non-Performing assets, standard assets, sub-standard assets, doubtful assets and loss assets. We have divided the entire period into two parts. In the first phase we have seen that co-efficient of variation of Percentage of loss assets to total advance is 0.08 which is the least compared to doubtful assets, sub-standard assets and standard assets as well as total Non-Performing Assets. Again we see sub-standard asset has lower co-efficient of variation than doubtful asset, standard asset and total non-performing assets. In this phase the series of non-performing assets of loss assets is consistent than any other assets.

**Table- II: Co-efficient of Variation of Non-Performing Assets**

Year	%of total NPA to total advance	% of standard assets to total advance	%of sub standard assets to total advance	%of doubtful assets to total advance	%of loss assets to total advance
2001-2005	5.06	5.06	0.52	1.62	0.083
2006-2011	0.15	0.15	0.014	0.14	0.018

### Author's Calculation

Again in the second phase of period, we also see co-efficient of variation of percentage of loss assets to total advance is the least but co-efficient of variation of total non-performing assets to total advance, in which percentage of standard asset to total asset has drastically reduced from earlier phase. This means in later phase the performance of series of non-performing assets of different categories have been very much consistent. This is because values of co-efficient of variation of all categories of non-performing assets have been reduced in the second phase. Increase in standard asset of a bank is not bad because it is not the non-performing asset in real sense. In table-II, in 2000-01, the standard asset/total standard asset of public sector banks was 78.30%, which was the highest among the sectoral banks. It remained highest all the time concerned. It has been reduced to 72.91% in 2003-04

but in the next year it increased to 75.90%. In the following year, there is declining trend, up to 2008-09. Thereafter, it has increasing trend. It means that in public sector banks there is fluctuation in the percentage of standard asset.

**Table- III : Standard Assets of all banks sector wise as a percentage of Total Standard Assets of all Scheduled Commercial Banks**

Year	Public Sector Banks	Private sector Banks	Foreign Banks	All Scheduled Commercial Banks
2001	78.30	13.15	8.55	100
2002	74.24	17.91	7.84	100
2003	73.84	18.92	7.23	100
2004	72.91	19.95	7.12	100
2005	75.90	17.26	6.83	100
2006	72.86	20.66	6.46	100
2007	72.44	20.76	6.80	100
2008	72.79	20.18	7.03	100
2009	75.59	18.45	5.96	100
2010	77.19	17.78	5.03	100
<b>Average</b>	<b>74.61</b>	<b>18.50</b>	<b>6.89</b>	<b>100</b>

**Source: Handbook of Statistics on Indian Economy, various years**

#### **Author's Calculation**

The percentage of standard asset to total standard asset of private sector banks is least in 2000-01 i.e. 13.50% and gradually starts increasing from the next year reached to 20.76% in 2006-07 but after that it shows declining trend and reduced to 17.78% in 2009-10. In case of Foreign Banks, percentage of standard assets to total standard assets in 2000-01 is 8.55% which is highest and in the following years it declines gradually and reached to 6.80% in 2006-07, thereafter increased to 7.03% in 2007-08, again shows declining trend in the following year.

This shows that private sector banks shown more improvement in their performance in comparison to public sector banks and foreign banks. The performance of public sector banks shown fluctuating trend.

The co-efficient of variation of a series of observation measures the consistency or performances of the series. In table IV we have found the co-efficient of variation of standard assets of different sector of banks. We have divided the entire part into two parts. In the first phase we have seen that co-efficient of variation of percentage of standard assets to total non-performing assets of foreign banks is 0.38 which is least in comparison to public sector banks and private sector banks. Again, we see public sector banks have lower co-efficient of variation than private sector banks. In this phase the series of standard assets of foreign banks is consistent than any other sectoral banks.

**Table- IV: Co-efficient of Variation of Standard Assets**

year	Public sector banks	Private sector banks	Foreign banks
2001-2005	3.60	5.43	0.38
2006-2010	3.92	1.49	0.51

#### **Author's Calculation**

Again, in the second phase, we also see co-efficient of variation of percentage of standard assets to total non-performing assets of foreign banks is the least, after that private sector banks have lower co-efficient of variation showing that the private sector banks and foreign banks have more consistent performance in the second phase in comparison to public sector banks whose co-efficient of variation has increased in the second phase showing inconsistent performance.

In table- V we have analyzed the position of non-performing assets and its impact on the profit and loss of scheduled commercial banks group wise. We can see that the whole period is divided into two phase. In the first phase non-performing assets as a percentage of total advance is highest in 2000-01 at 11.44% and profit is least in the same year at 1.53%. Thereafter non-performing asset shows decreasing trend and become least in the first phase in 2003-04 at 0.72 and the profit in the same year for the first phase is highest in the same year at 2.66. The average of non-performing asset as a percentage of advance is 7.32% at which average profit is 2.14%. Thus we can see that as percentage of non-performing asset to gross advances decreases profit increases.



**Table- V: Position of Non-Performing Assets and Gross Profit/ Loss Percentage of Total Assets in Scheduled Commercial Bank Group Wise**

Year	Scheduled commercial banks		Public sector banks		Private sector banks		Foreign banks	
	Gross NPA to Gross Advance	Profit and Loss	Gross NPA to Gross Advance	Profit and Loss	Gross NPA to Gross Advance	Profit and Loss	Gross NPA to Gross Advance	Profit and Loss
2001	11.44	1.53	12.38	1.34	8.54	1.74	6.85	3.05
2002	10.42	1.94	11.09	1.88	9.64	0.66	5.49	3.10
2003	8.84	2.39	9.36	2.31	8.07	1	5.33	3.20
2004	0.72	2.66	7.78	2.67	5.83	0.95	4.81	3.68
2005	5.16	2.17	5.44	2.18	4.57	0.83	4.81	2.98
<b>Average</b>	<b>7.32</b>	<b>2.14</b>	<b>9.21</b>	<b>2.08</b>	<b>7.33</b>	<b>1.04</b>	<b>5.46</b>	<b>3.20</b>
2006	3.48	1.95	3.71	1.88	2.45	1.71	2.07	3.34
2007	2.66	1.91	2.81	1.75	2.36	1.84	1.92	3.51
2008	2.39	1.93	2.34	1.67	2.75	2.05	1.91	3.84
2009	2.44	2.33	2.09	2.47	3.25	-	4.30	4.95
2010	2.50	2.17	2.27	1.87	2.97	2.68	4.26	3.70
2011	2.25	2.26	2.30	2.06	2.45	2.58	2.54	3.52
<b>Average</b>	<b>2.62</b>	<b>2.09</b>	<b>2.59</b>	<b>1.95</b>	<b>2.71</b>	<b>2.17</b>	<b>2.83</b>	<b>3.81</b>

**Source: Handbook of Statistics on Indian Economy (RBI)**

### **Author's Calculation**

In the second phase, the percentage of non-performing asset to gross advance in 2005-06 is 3.48 which is highest and profit in the same year is 1.95 which is least. Thereafter non-performing asset to gross advance shows decreasing trend while profit and loss shows increasing trend in this phase as well. So, this shows that there exist inverse relation between non-performing asset and profit. We have observed the same trend and relation between non-performing asset and profit in case of public sector banks, private sector banks and foreign banks.

We have done the regression analysis of table-V on the basis of t-value, corresponding p-value and also value of  $R^2$  and F statistics.

### Effect of Non-Performing Assets on Profit or Loss of Scheduled Commercial Banks

$$Y = 02.32 - 0.04 N$$

Here, Y = Profitability

$$t = 16.77 \quad -1.82$$

N = Non-Performing Assets

$$p = 0.00 \quad 0.10$$

$$R^2 = 27 \%$$

Thus, we see from our regression result that Non-Performing Assets for Scheduled Commercial banks is significant to influence its profitability for concerned period at ten percent level but there exist a negative relation between Non-Performing Assets and Profitability of Scheduled commercial banks. This means as Non-Performing Assets increases, profitability of banks obviously falls. Also we have  $R^2 = 0.27$  and  $F = 3.33$  so that we have overall significance, only 27% is explained by our regression the rest 73% remains unexplained because we have not captured other banking variables that can influence the profitability of banks.

### Effect of Non-Performing Assets on Profit or Loss of Public sector Banks

$$Y = 2.08 - 0.01 N$$

Here, Y = profitability

$$t = 9.56 \quad -0.40$$

N = Non-Performing Assets

$$p = 0.00 \quad 0.70$$

$$R^2 = 0.02$$

here, we get very insignificant result i.e., Non-Performing Assets of public sector banks is very much insignificant to influence the profitability of public sector banks. This is because over time non-performing assets of public sector banks have drastically reduced from 12.38% in 2001 to near about 2% in the year 2011, so, profitability of such banks is actually caused by the other factors like credit deposit ratio, number of customers, investments in securities etc.

### Effect of Non-Performing Assets on Profit or Loss of private Sector Banks

$$Y = 2.09 - 0.13 N$$

Here, Y = Profitability

$$t = 4.19 \quad -1.45$$

N= Non-Performing Assets

$$p = 0.00 \quad 0.18$$

$$R^2 = 0.19$$

$$F = 2.10$$

In case of Private Sector Banks, we also get a significant result i.e. Non-Performing Assets of Private Sector Banks is statistically significant to influence the profitability at 10% level. There is also overall significance. Here, we also see only 20% is explained by regression, the rest 80% is explained by other banking variables.

### **Effect of Non-Performing assets on Profit or Loss of Foreign banks**

$$Y = 3.90 - 0.09 N$$

Here, Y= Profitability

$$t = 8.55 \quad -0.85$$

N = Non-performing Assets

$$p = 0.00 \quad 0.42$$

$$R^2 = 0.08$$

Here, also we get very insignificant result i.e. non-performing assets of foreign banks over the period are not statistically significant to influence the profitability of such banks. This is because the performances of foreign banks have improved over the time due to decrease in the percentage of non-performing assets to total advance and also there is consistency in the profit earning trend of foreign banks. Percentage of standard assets also increased resulting in reduction of non-performing assets.

### **FINDINGS:**

- ❖ In table number one, it was found that in 2000-01 percentage of total non-performing asset to total advance is highest i.e. 11.45% after that it gradually started decreasing and comes to 7.19% in 2003-04. But thereafter, percentage of non-performing assets started decreasing at a fast rate and reduced to 2.35% in the year 2010-11. The percentage of standard asset to total advance is showing increasing trend from 88.55% in 2000-01 to 97.65% in 2010-11. The percentage of sub-standard asset to total advance in 2000-01 is 3.26% which is highest and it reduced to 0.994% in 2010-11. , The percentage of doubtful asset to total advance is highest in 2000-01 i.e. 6.76% and gradually reduced to 1.12% in 2010-11. In case of loss assets, the percentage of loss asset to total advance is highest in 2000-01 i.e. 1.43% which reduced to 0.85% in 2003-04 and in 2008-09 it reduced to 0% but thereafter increased to 0.24% in 2010-11.

- ❖ In table number two, In the first phase we have seen that co-efficient of variation of Percentage of loss assets to total advance is 0.08 which is the least compared to others. In this phase the series of non-performing assets of loss assets is consistent than any other assets. Again in the second phase of period, we also see co-efficient of variation of percentage of loss assets to total advance is the least but co-efficient of variation of total non-performing assets to total advance, in which percentage of standard asset to total asset has drastically reduced from earlier phase. This means in later phase the performance of series of non-performing assets of different categories have been very much consistent.
- ❖ In table-III, in 2000-01, the total standard asset of public sector banks was 78.30%, which was the highest among the sectoral banks. It remained highest all the time concerned. In the following year, there is declining trend, up to 2008-09. Thereafter, it has increasing trend. It means that in public sector banks there is fluctuation in the percentage of standard asset. The percentage of standard asset to total standard asset of private sector banks is least in 2000-01 i.e. 13.50% and gradually starts increasing from the next year up to 2006-07 but after that it shows declining trend and reduced to 17.78% in 2009-10. In case of Foreign Banks, percentage of standard assets to total standard assets in 2000-01 is 8.55% which is highest and shows fluctuating trend in the following year. This shows that private sector banks shown more improvement in their performance in comparison to public sector banks and foreign banks.
- ❖ In table number IV we have seen that in the first phase co-efficient of variation of percentage of standard assets to total non-performing assets of foreign banks is 0.38 which is least in comparison to public sector banks and private sector banks. In this phase the series of standard assets of foreign banks is consistent than any other sectoral banks. Again, in the second phase, we also see co-efficient of variation of percentage of standard assets to total non-performing assets of foreign banks is the least which has increased in the second phase showing inconsistent performance.
- ❖ In table number V we see that in the first phase non-performing assets as a percentage of total advances are highest in 2000-01 at 11.44% and profit is least in the same year at 1.53%. Thereafter non-performing asset shows decreasing trend and become least in the first phase in 2003-04 at 0.72 and the profit in the same year for the first phase is highest in the same year at 2.66. Thus we can see that as percentage of non-performing asset to gross advances decreases profit increases. In the second phase, the percentage of non-performing asset to gross advance in 2005-06 is 3.48 which is

highest and profit in the same year is 1.95 which is least. Thereafter non-performing asset to gross advance shows decreasing trend while profit and loss shows increasing trend in this phase as well. So, this shows that there exist inverse relation between non-performing asset and profit.

- ❖ We have done the regression analysis of table-V on the basis of t-value, corresponding p-value and also value of  $R^2$  and F statistics. Our regression analysis in case of all scheduled commercial banks shows that non-performing assets significantly influence the profitability at 10% level but there exists a negative relation between Non-Performing Asset and Profitability of Scheduled Commercial Banks. . In case of public sector banks, we get very insignificant result i.e. Non-Performing Asset is very insignificant to influence the profitability of public sector banks. In case of Private Sector Banks, we also get a significant result i.e. Non-Performing Assets of Private Sector Banks is statistically significant to influence the profitability at 10% level. In case of Foreign banks, we also get a very insignificant result i.e. non-Performing Assets of Foreign Banks is not statistically significant to influence the profitability.

## Section-4

### CONCLUSION OF THE STUDY:

Our study on “Trends of Non-Performing Assets and its Impact on the Profitability of Scheduled Commercial Banks in India in Recent Years” reveals that percentage of total non-performing assets to total advance has reduced drastically from 11.45% in 2001 to 2.35% in 2011 which shows that commercial banks as well as Reserve Bank of India have taken effective measures to reduce the percentage of non-performing assets in order to increase the profitability of commercial banks. Among the various steps taken by the Reserve Bank of India, one important measure was allowing banks to restructure their advances, as a onetime measure. The percentage of total non-performing assets has reduced mainly due to reduction in the percentage of sub-standard assets, doubt full assets and loss assets and also due to increase in the percentage of standard assets which is beneficial for their profitability. The performance of series of non-performing assets of different categories has been very much consistent in the phase 2006-10 because value of co-efficient of variation of all categories of non-performing asset has reduced in this phase.

The percentage of standard assets to total standard asset shown increasing trend in private sector banks, mixed trend in public sector banks and decreasing trend in foreign banks showing that private sector banks have implemented more effective measure to collect the interest and principal on loans advanced to their customers in comparison to public sector and foreign banks.

Our regression analysis in case of all scheduled commercial banks shows that non-performing assets significantly influence the profitability at 10% level but there exists a negative relation between Non-Performing Asset and Profitability of Scheduled Commercial Banks. Also we have  $R^2 = 0.27$  and  $F = 3.33$  show that we have overall significance. Only 27% is explained by our regression the rest remained unexplained because we have not captured other banking variables that can influence the profitability of banks. In case of public sector banks, we get very insignificant result i.e. Non-Performing Asset is very insignificant to influence the profitability of public sector banks. This is because over time Non-Performing Asset of public sector banks have drastically reduced from 12.38% in 2000-01 to near about 2% in 2010-11, so, profitability of such banks is actually caused by the other factors like credit deposit ratio, number of customers, investment in securities and other factors. In case of Private Sector Banks, we also get a significant result i.e. Non-Performing Assets of Private Sector Banks is statistically significant to influence the profitability at 10% level. In case of Foreign banks, we also get a very insignificant result i.e. non-Performing Assets of Foreign Banks is not statistically significant to influence the profitability.

## **Recommendation**

Ever since the introduction of the financial sector reforms in India, the non-performing assets of the banking system have been catching attention. Non-performing assets cause serious strain on the profitability as, on the one hand banks cannot book income on such accounts and on the other hand they are required to charge the funding cost and provision requirements to their profits. A mounting level of Non-Performing Asset in the banking sector can severely affect the economy in many ways. If Non-Performing Assets are not properly managed it can cause financial and economic degradation which in turn hampers the investment which is crucial for the profitability of all Scheduled Commercial Banks. In order to reduce the percentage of Non-performing Assets so as to improve the profitability of commercial banks following steps are recommended:-

- Harder steps should be taken by the commercial banks to collect their dues from the customers.
- They should check the credibility of the customers before granting loans.
- The assets taken as security against loan advanced should be verified whether that assets exist in real.
- Proper mechanisms for reducing the percentage of non-performing assets should be strictly implemented as there are many mechanisms which are not being implemented in a correct way due to which this problem of non-performing asset has come to alarming situation.
- The reduction of the higher proportion of the statutory liquidity ratio and the cash reserve ratio.
- Phasing out the directed credit programme and compelled the banks to earmark the financial resources for the needy and poor sectors at concessional rates of interest.

Thus all the steps recommended here should be implemented properly so that the declining trend of Non-Performing Assets remain consistent which helps the banks to improve their profitability and the improved profitability of all scheduled commercial banks contribute positively towards the economic development of India.

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## **A Study on Appraisal of Formal Networks as Value Creator to Small Enterprises**

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### **ABSTRACT:**

Small Enterprises play a catalytic role in the development process of the Indian economy as these constitute a major part of the industrial activities in the country. Success of small firms has social as well as economic consequences and to succeed in spite of their own resource scarcity small enterprises need to utilize external resources effectively through their entrepreneurial network relationships. Small enterprises forge relationship with other actors in their environment through cooperation and networking to obtain necessary resources, support and other benefits which they may be unable to generate by themselves. Memberships in formal networks are one such source of external resources and benefits for small firms. Being one of the most common forms of networks for all forms of businesses these membership organizations are engaged in promoting the business interests of their members.

Formal networks in the form of business associations and industry/trade specific associations have the potential to play an important role in the process of stimulating entrepreneurial networking. Large firms have long been active participants in formal networks, using the organization to advance their goals in a wide range of areas, from regulatory issues to research to industry image improvement. But small firms can benefit from association memberships as well, provided they find an organization that adequately reflects their priorities and needs, which may be dramatically different from those of big corporations. The purpose of this study is to delve into the benefits from networking in the form of business associations and draw a comparison between benefits obtained from formal vis-à-vis

informal networks. Findings of this paper is based on an empirical study conducted via structured questionnaire on a sample of 100 small enterprises in West Bengal with 50 firms having membership in industry/trade associations and business associations as the experimental group and another 50 firms using only informal connections as the control group.

**Key words:** Small enterprises, formal networks, business associations, industry/trade specific associations, networking benefits.

## 1. INTRODUCTION:

Small enterprises are a vital developing force of the Indian economy and represent the majority of all the enterprises. However, their own development is constrained due to numerous problems such as absence of adequate and timely banking finance, limited capital and knowledge, non-availability of suitable technology, low production capacity, ineffective marketing strategy, identification of new markets, constraints on modernisation & expansions, non-availability of highly skilled labour at affordable cost and poor follow-up with various government agencies to resolve problems etc. To overcome their constraints small firms may resort to external support through entrepreneurial networks. Networks can provide resources to small firms in the form of access to knowledge and information related to different aspect of enterprises functioning like management, finance, technology, marketing, production, etc. Research emphasizes the functionality of networks for managing resource dependencies and fostering learning and knowledge exchange (Cliquet, 2000; Windsperger, 2004). Networks can provide efficiency advantages that markets or hierarchies do not possess; also, networks can allow firms to secure resources that would not be available on markets at all, such as reputation or customer contacts (Uzzi, 1996). Thus, by creating economic opportunities that are difficult to replicate in any other organizational form, networks can serve as a prime coping response to individual resource scarcity in the quest for competitive advantage and economic rents (Baum et al., 2000; Gulati et al., 2000; Goerzen, 2007). Previous research has documented the dramatic growth of cooperative arrangements across industries in recent years, the variety of contractual agreements that formalize relationships, and the multitude of reasons why firms enter into such relationships (Parkhe et al., 2006). SME decision-makers also agree that networks can be advantageous for small firms, potentially conferring the ability to tap into new markets, access scale economies,

obtain complementary resources in underdeveloped value chain activities, or receive endorsements from reputable incumbents (Hausschild and Wallacher, 2003; Reuer and Ariño, 2007)

The term networks describes a collection of “actors” (people, departments or businesses), and their strategic links (family, community, finance, business alliances) with each other (Johnsen and Johnsen, 1999). The network relationships that small firms enter into with other actors in their environment for obtaining necessary business resources, information and other moral support may be both formal and informal in nature. The purpose of this paper is to draw a comparative study into the networking benefits obtained by sampled small firms engaged in formal networking in the form of business and industry/trade specific associations and informal networking like family, social, internal and buyer/supplier networks. The rest of the paper is organized as follows.

## **2. THEORETICAL REVIEW:**

The concept of networks and networking was originally developed in sociology and anthropology and later used in organizational behaviour and small business development. As defined by Axelsson and Easton (1992), a network involves “sets of two or more connected exchange relationships”. According to the network perspective, the nature of relationships established between various parties will influence strategic decisions, and the network involves resource exchange among its different members (Sharma, 1992). Mitchell (1969) defined networks as “a specific type of relations linking a defined set of persons, objects and events” (Paasche et al., 1993). In organizational behaviour, entrepreneurship has been conceptualized as a dynamic process that requires linkages or networks between key components of the process for its successful development. This approach is viewed as being embedded in a social context, channelled and facilitated or constrained and inhibited by people’s positions in social networks (Aldrich and Zimmer, 1986; Aldrich et al., 1987; Larson and Starr, 1993).

Studies on small business enterprises and their networks are largely concerned with the entrepreneur and his network relations (Birley and Cromie 1988, Cromie et al. 1994, Curran et al. 1993, Donckels and Lambrecht, 1995, Ozcan 1995). The entrepreneur’s personal relationships are taken into consideration study because the ‘entrepreneur’ is the main composer in a small business firm.

Some of the network derived benefits identified in the literature are—

- **Start-up/Seed Capital-** Dyer and Handler, (1994), Reynolds *et al* (2004) found that the initial capital for small firms generally comes from personal and family networks.
- **Information Sharing:** Social ties or networks are regarded as important vehicles for exchanging and transferring information in the SME context (Uzzi, 1997; Vanhaverbeke, 2001).
- **Access to New Markets:** Networking allows SMEs to combine the advantages of smaller scale and greater flexibility with economies of scale and scope in larger markets – regional, national and global (OECD, 2000).
- **Innovation Support:** The benefits of both intra-firm (Tsai and Ghoshal, 1998) and inter-firm networks (Molina-Morales and Martinez- Fernandez, 2010) are evident in that, networks and associated social capital variables were found to contribute to both product and process innovation in small firms.
- **HR Support:** Proper connections can provide individuals with better jobs, and firms with the required human resource (Miller et. al., 2007; Fuller-Love and Thomas, 2004; Bennett and Ramsden, 2007).
- **Legal and advocacy benefits:** The core services provided by membership associations to small firms involve legal services and representing or lobbying for the interests of their members (Bennett & Ramsden, 2007).

Several studies have revealed that small firms rely on multiple networks for deriving benefits which can address their problems of resource scarcity and result in improved performance (Premaratne, 2002; Wu, 2008; Gronum et. al. 2012). A review of the literature highlights a number of network forms. Based on networks identified by O'Doherty(1998) and Inkpen& Tsang (2005) networks can be classified into two broad categories- formal and informal. Membership based associations like Industry/trade specific associations and business associations are formal networks guided by set rules, regulations and guidelines and firms enter into these networks by choice. Family networks, social networks, internal networks and buyer-supplier networks which have no formal guiding principles are considered as informal networks and firms are naturally embedded in them.

### **3. OBJECTIVE OF THE STUDY:**

Existing literature on networking and entrepreneurship reveals that various networks enable entrepreneurs to gain access to resources that are necessary for them to achieve their aims. The objective of the study is to look into various types of networks small firms involve in, their perception about the level of usefulness and benefits derived from those networks while drawing a comparison among firms involved in formal and informal networking. The study tries to get an insight into the motivational factors behind the small firms' networking preferences.

### **4. METHODOLOGY:**

This study on network relationships of SMEs is based on a set of primary data collected over structured questionnaires. The questionnaire was formulated incorporating the predominant theories advanced in the literature and a review of previous survey instruments. The questionnaire was piloted over a sample of 20 firms in order to ensure content validity. Sourcing detailed information on SMEs is a universal problem, but it is particularly problematic in West Bengal. The literature that was used to design the questionnaire had been applied in countries having an efficient SME data bank providing financial information about the firms under study. But in the absence of a single window database in West Bengal we had to conduct a door-to-door enquiry. Data has been collected from 100 firms, taking 50 firms having membership in different associations as the experimental group. Another 50 firms not under the umbrella of any associations were selected as the control group. The sample of member firms was picked out from a population of members list of five Business Associations using random number table. These associations were selected from list of Industry Associations available from the Directorate of Micro and Small Scale Enterprises, Government of West Bengal and also from other websites. Two of them are Formal Business Associations (Bengal National Chamber of Commerce and Industries (BNCCI) and Federation of Small and Medium Industries (FOSMI)) and three are Trade /Industry specific Associations (Computer Association of Eastern India (COMPASS), Bengal Hosiery Manufacturers Association (BHMA) and Electronic and Accessories Manufacturers Association (ELMA)). Another sample of 50 firms not belonging to any Association were randomly selected on a trial & error basis from a population of small businesses (having filed Entrepreneurship Memorandum with District Industries Centre as per the MSMED\* Act

2006) in the suburban and urban areas of West Bengal spread across different industries. The demographic profile of the sampled firms is presented in Table 1.

**TABLE 1: DEMOGRAPHIC PROFILE OF SAMPLE FIRMS**

<b>Demographic</b>	<b>Profile</b>	<b>Member Firms</b>	<b>Non-member Firms</b>
Nature of Activity	Manufacturing	72%	52%
	Service & Trade	28%	48%
Form of Business	Unincorporated	54%	86%
	Incorporated	46%	14%
Firm age	Below 15 years	20%	62%
	15 to 30 years	56%	36%
	Above 30 years	24%	12%
Firm Size	Below 6 employees	6%	26%
	7 to 10 employees	20%	50%
	11 to 20 employees	42%	20%
	21 to 100 employees	32%	4%

*Source: Field Survey 2012-13*

The respondents were exposed to questions on their firm's profile and level of usefulness and benefits they derive from extended family networks, social networks, industry/trade specific networks, formal business networks, professional networks, training networks, informal networks, internal networks and state supported networks and other networks involving buyers and suppliers. The next section focuses on the inferences drawn on the basis of data collected from our field study.

## **5. DATA ANALYSIS:**

This section of the paper presents perception of the sampled member and non-member sample firms about the level of usefulness & benefits derived from different networks. Perception of the sampled member firms on usefulness of networks is presented in Table 2

and Chart 1. Table 2 shows that 74% of the member firms find industry/trade specific networks to be very useful and 24% find it useful. 70% member firms found business associations to be very useful and 20% found it to be useful. So, it can be said that 90% of the sampled member firms had the perception that formal network relationships were useful for their business. Among the member firms, 34% found extended family networks to be very useful and 18% found social networks very useful. Internal networks were very useful to 22% and 72% found buyer-supplier networks useful. The data reveals that firms engaged in formal networking rely more on their formal ties and buyer-supplier networks compared to other network forms for acquiring business resources.

**TABLE 2: PERCEPTION OF SAMPLED MEMBER FIRMS ON USEFULNESS OF NETWORKS**

Network Types	Level of Usefulness			Total
	Hardly useful	Useful	Very useful	
<b>Industry/Trade Specific Networks</b>	1 (2%)	12 (24%)	37 (74%)	50
<b>Business Associations</b>	5 (10%)	10 (20%)	35 (70%)	50
<b>Extended Family Networks</b>	17 (34%)	16 (32%)	17 (34%)	50
<b>Social Networks</b>	21 (42%)	20 (40%)	9 (18%)	50
<b>Internal Networks</b>	4 (8%)	30 (60%)	16 (32%)	50
<b>Buyer-Supplier Networks</b>	3 (6%)	11 (22%)	36 (72%)	50

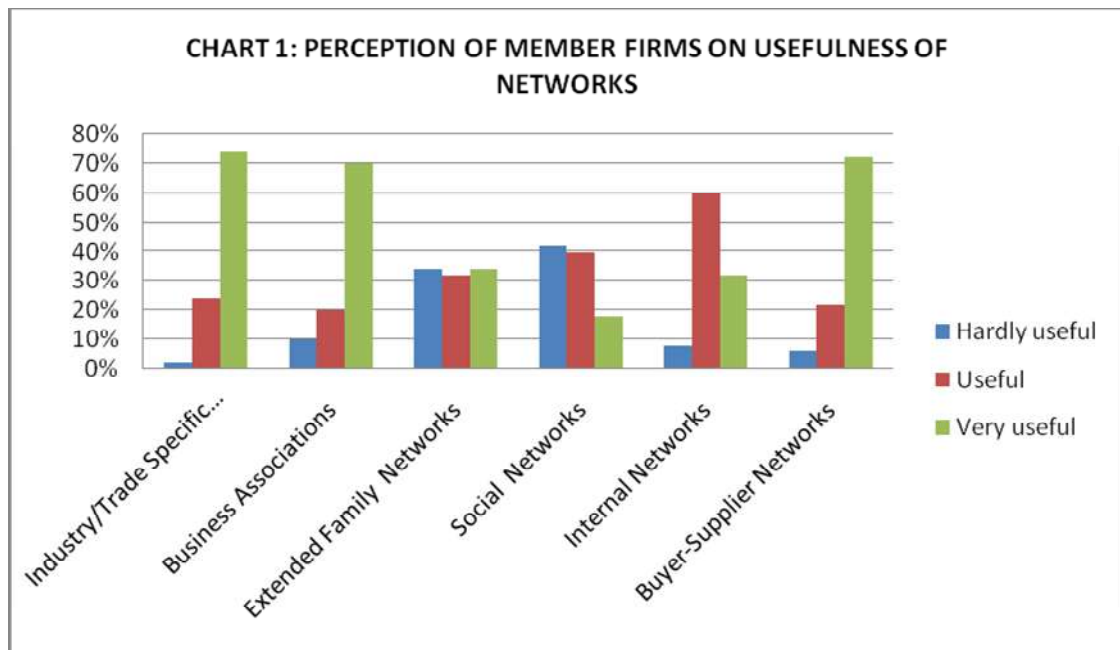
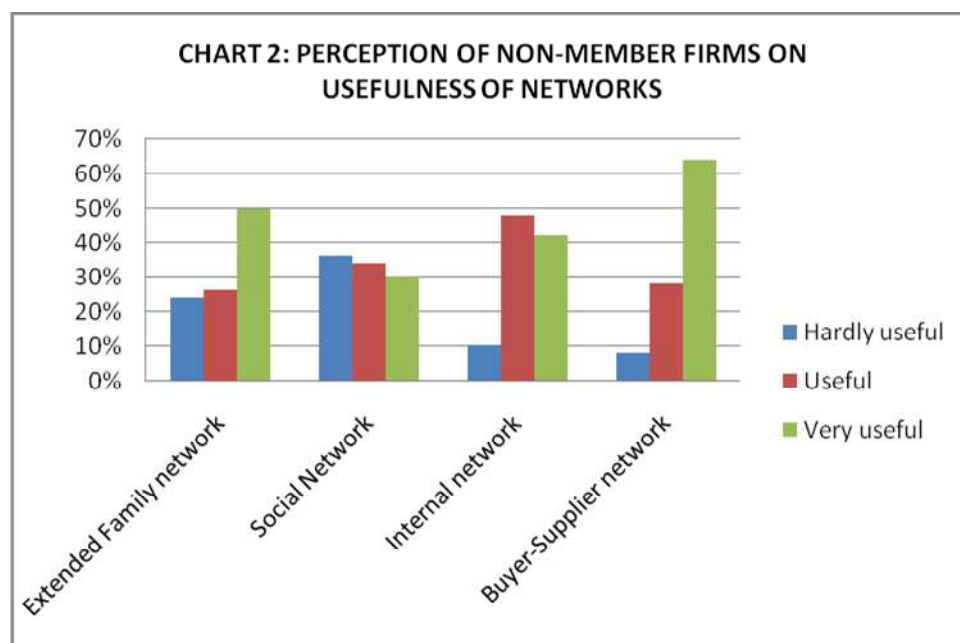


Table 3 and Chart 2 present the perception of the non-member firms about the level of usefulness of various networks. 50% sampled non-member firms found family networks very useful, 30% found social networks very useful, internal networks were very useful to 42% and 64% found buyer-supplier networks very useful. Non-member firms found informal networks more useful compared to member firms as they do not have access to resources provided by the membership organisations and have to rely on their ties in informal networks for business resources.

**TABLE 3: PERCEPTION OF SAMPLED NON-MEMBER FIRMS ABOUT LEVEL OF USEFULNESS OF NETWORKS**

Network Types	Level of Usefulness			Total
	Hardly useful	Useful	Very useful	
Extended Family Networks	12 (24%)	13 (26%)	25 (50%)	50
Social Networks	18 (36%)	17 (34%)	15 (30%)	50
Internal Networks	5 (10%)	24 (48%)	21 (42%)	50
Buyer-Supplier Networks	4 (8%)	14 (28%)	32 (64%)	50





Entrepreneurs of sampled member and non-member firms who claimed a network relationship to be useful were asked to identify the benefits obtained from a category of six benefits mentioned in the questionnaire. These are- marketing benefits, benefits of information sharing, staff and HR support, benefits of financial support, benefits of innovation support and benefits of legal and advocacy services. Literature supports that small firms obtain these benefits from various network relationships. Data collected from field survey substantiates that small firms obtain benefits from multiple networks.

Sampled small firms in the study not only had ties in multiple networks but also claimed to have obtained multiple benefits from those networks. Table 4 presents the benefits obtained by the sampled member and non-member firms from their various network ties they found to be useful or very useful. Among the member firms who found industry/trade specific networks to be of use, 47% obtained benefits of information sharing, 33% obtained marketing benefits and 29% obtained HR support. Few firms received innovation support, legal and advocacy support and financial support. Among member firms who found business associations useful, 42% obtained information sharing benefits and 31% derived marketing benefits followed by other benefits. 62% among the member firms who used family networks obtained financial support, 54% used social networks for marketing benefits and 62% used internal networks for information sharing. Buyer supplier network was used by 62% member

firms for marketing benefits and 56% used it for information sharing. Among the non-member firms also 74% firms using family networks obtained financial support, 46% using social networks used it for marketing benefits, 56% using internal networks shared information through it and 58% used buyer supplier networks for marketing benefits.

**TABLE 4: BENEFITS DERIVED FROM NETWORKS (approx. percentage)**

Networks	Networking Benefits					
	Marketing benefits	Benefits of information sharing	Staff and HR Support	Benefits of financial support	Benefits of innovation support	Benefits of legal and advocacy services
<b>Member Firms</b>						
<b>Industry/Trade Specific Networks</b>	33%	47%	29%	6%	24%	12%
<b>Business Associations</b>	31%	42%	24%	11%	20%	18%
<b>Extended Family Networks</b>	6%	21%	10%	62%	10%	0
<b>Social Networks</b>	54%	36%	0	0	10%	0
<b>Internal Networks</b>	22%	60%	12%	0	24%	0
<b>Buyer-Supplier Networks</b>	62%	56%	0	0	20%	0
<b>Non-Member Firms</b>						
<b>Extended Family Networks</b>	10%	26%	14%	74%	8%	0
<b>Social Networks</b>	56%	42%	0	0	2%	0
<b>Internal Networks</b>	34%	56%	20%	0	6%	0
<b>Buyer-Supplier Networks</b>	58%	40%	0	0	12%	0

It is evident from the Table 4 that the sampled small firms in West Bengal maintain ties in multiple networks which may be both formal and informal in nature. They mostly obtain benefits of marketing support and information sharing from their network relationships. Extended family network were found to provide financial support as most of the firms claimed to have obtained their start-up or seed capital from relations in this network. Data reveals that member firms obtained more HR support and innovation support from their formal and informal networks compared to non-member firms who obtained very less innovation support from their networks. Few member firms claimed to have obtained legal and advocacy services from industry networks and business associations which is totally unavailable to the non-member firms. However the industry networks and business associations need to strengthen their legal and advocacy services and HR support services so that their members can avail more such benefits.

To understand the level of each benefit obtained by the sampled member and non-member firms, the respondents were asked to rate each benefit on a five point likert scale (1= very low, 2 = low, 3 = average, 4 = high, 5 = very high). An average score of the six benefits rated by the sampled firms was computed to form a comprehensive benefit index (Ben\_Index) for each firm. To draw a comparison between the mean values of comprehensive benefits (Ben\_Index) received through network relationship among the member and non-member firms, independent sample t-test was performed using SPSS 17. The descriptive statistics and t-value is presented in Table 5. Examination of t-value reveals that benefits derived by member and non-member firms differ significantly on the measure of composite benefit index (Ben\_Index) ( $t = 6.472$ ) with member firms enjoying higher level of benefits obtained compared to non-member firms.

**TABLE 5: DESCRIPTIVE STATISTICS AND T-TEST OF SOCIAL CAPITAL BENEFITS OF MEMBER AND NON-MEMBER FIRMS**

Benefits from Networks	Member Firms (N=50)		Non-member Firms (N=50)		t-value
	Mean	SD	Mean	SD	
Ben_Index	3.5467	.8268	2.3832	.9654	6.472*

\*Significant at .05 level

This substantiates our view that member firms embedded in formal networks derive greater benefits through various support services provided by the membership associations. Formal networks also provide a platform for interaction and cooperation among the member firms which may encourage them in various resource exchanges. Non-member firms embedded only in informal networks cannot avail the services and cooperative platform provided by membership associations which result in lower level of network derived benefits among these firms.

## **6. CONCLUDING REMARKS:**

- Marketing benefits received from formal networks coupled with informal connections may help the member firms to enter into new markets and expand their market base.
- Information sharing platform of formal networks provide the opportunity to share information about new techniques, suppliers, customers, or technology through interactions among the member firms which is supplemented by informal network relations.
- HR support in the form of training and skill development services and referrals for recruitment provided through formal networks may help member firms to upgrade skills and capacity of their workforce and recruit qualified employees which is a prerequisite for adoption of new and advanced techniques in various functional areas. Non-member firms cannot avail this benefit.
- Ideas, information and knowledge, research and development through collaboration among network members and technical support from formal networks may boost innovative activities of the small firms.
- Non-member firms usually derive marketing support and share information from informal network connections like family networks, social networks, internal networks and buyer supplier networks. But unlike the member firms they are deprived of support services and cooperation received through formal networking.

Based on the findings, the study observes that membership in formal networks coupled with informal natural networks may enable small firms to obtain more benefits from their

networks. Small firms may be encouraged to enter into formal networking to complement the benefits naturally derived from informal networks. Formal networking may be encouraged among small firms as they have the potential to play a proactive role in guiding their members toward accessing the resources facilitating their advancement.

Finally, mention must be made of some of the limitations of the research. This study also suffers from some of the inherent limitations of all qualitative research and the outcomes are based on the perception of the respondents. Conducted on a limited sample of small firms from four districts of West Bengal we have compared formal and informal networks which are not exhaustive in nature. Future study may be conducted on the impact of network derived benefits on firm performance.

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## **Bioactive compounds, Uses and Cultivation of *Valeriana jatamansi* Jones-A Review**

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### **Introduction:**

*Valeriana jatamansi* Jones Syn. *Valeriana wallichii* (Bennet, 1987), popularly known as Indian valerian (English), Mushkibala (Kashmiri), Sughanthdawal or Tagar (Sanskrit), (Raina and Srivastava, 1992), is an important medicinal plant and is being labeled as critically endangered due to over-exploitation of rhizomes for its medicinal value, habitat degradation and other biotic interferences in its distribution ranges. The species witnessed a tremendous decline in its population size. It tells the tale of biotic interferences, which have brought it to the brink of extinction. If left as such and exploited at the same rate, in near future, the species will disappear forever. Thus, convention on international trade on endangered species notified *Valeriana jatamansi* in its schedule for conservation.

Keeping in view the immense medicinal importance and critically endangered status of *Valeriana jatamansi* it becomes necessary to study various reproductive constraints if any which in turn will prove to be helpful in planning the conservation strategies. Nonetheless, the mounting demand of this plant species from various sources necessitates its domestication and propagation in a big way outside its natural habitat. A thorough understanding of their reproductive and growth biology as well as identification of biological and ecological constraints leading to their reducing fitness, restricted distribution, or even extinction is, therefore essential so that one is able to predict their behavior under *ex situ* cultivation and develop strategies for their successful conservation. This devised programme of the study on *Valeriana jatamansi*

can help in developing certain protocols to combat the problems that impede regeneration. Further, the study of reproductive biology can provide important paradigm for conservation, reclamation and restoration of *Valeriana jatamansi*.

## Botanical Accounts

### Habit and habitat of the plant:

Herbs, perennial. Plants hermaphroditic, gynodioecious, polygamo-dioecious, or dioecious, glabrous or variously pubescent, villous or hirsute, hairs 1- to several celled, white or translucent. Rhizomes elongate, with fibrous roots, or rhizomes reduced, with fascicled, often clavate, roots. Taproots absent (Chinese spp.). Stolons present or absent. Basal leaves rosulate, petiolate or spatulate, undivided, pinnate or pinnatifid, persistent or caducous. Cauline leaves opposite, petiolate to sessile; petiole length typically diminishing upward along stem; blade pinnate, pinnatifid, or undivided. Inflorescence paniculiform or corymbiform, at anthesis: flowers in remote terminal clusters or in a densely capitate head, branches elongating in fruit; lowermost bracts often lobed, bracts otherwise simple and entire; bracteoles simple, similar to bracts; flowers bisexual. Calyx a ring at anthesis, unfurling into 5–15 white, plumose segments, 4–8 mm, in mature fruit. Corolla funnelform, rotate or salverform; tube usually gibbous near base; limb 5-lobed. Stamens 3 (4 in *Valeriana kawakamii*), inserted on corolla tube. Achene compressed dorsally, 3-veined on abaxial side, 1-veined on adaxial side, sterile locules reduced; crowned by persistent, plumose calyx, segments 2–7 mm.

### Geographical distribution:

Valerianaceae comprises of @ 350 species distributed throughout the World (except Australia and New Zealand), mostly at high elevations and with many species in alpine zones (Backlund and Moritz, 1998). Bell (2004) labeled Valerianaceae as a natural group of 350 species of cosmopolitan distribution comprising of 13 genera with 200 species chiefly confined to temperate regions. *Valeriana jatamansi* Jones (Syn. *Valeriana wallichii* is distributed in all the temperate regions except Australia, (Jain, 1968; Bennet, 1987). Several species of *Valeriana* have also been reported from Andean Chile, Brazil, South Africa and Sub-tropical Asia. About 12 species of genus *Valeriana* have been reported from India (Anonymous, 1976). Rao *et al.* (1977) have

reported 10 species of *Valeriana* from India. Out of these *Valeriana jatamansi* has been reported to be widely distributed in temperate Himalayas at an altitude ranging from 1500m in Khasi Hills to 3000m in Jammu and Kashmir, Himachal Pradesh and Bhutan (Kritikar and Basu, 1975).

Mukerjee, (1953) while assessing distribution of *Valeriana officinalis* reported it to be growing only in restricted sites of North Kashmir at an altitude of 2400 to 2700m. However, *Valeriana jatamansi* according to Chauhan and Khosla (1988) is sporadically found in whole N.W. Himalayas.

Polunin and Stainton, (1987) reported the distribution of *Valeriana jatamansi* from Afghanistan to South west China and Burma. The herb was seen to grow at an altitude of 1500 to 2600m where in the surroundings were mainly comprising of *Bedula* (*Fiscus* species), *Laliguras* (*Rhododendron arboreum*).

*V. jatamansii* is indigenous to the Chinese Himalayas. Geographically, it is distributed from Afghanistan, Kashmir, North-west India, Nepal, Sikkim, North-east India, Bhutan and Myanmar to SW China. In Nepal it has been recorded from Langtang, Khamjing, Thulo Shyapru, Birdim, Cholangpati and Ghopte areas of Langtang National Park and Buffer Zone area.

### **Chemical constituents**

Valepotriates( Epoxy Iridoid Esters ):

Valepotriates are chemically unstable iridoid triesters in which the various hydroxyl groups are esterified with acetic, isovaleric, hydroxyisovaleric, and amethylvaleric acids. This alcohol has the structure of an iridoid cyclopenta-(c)-pyran with an attached epoxide ring.

Valtrate is the most abundantly present diene valepotriate alongwith 1-acevaltrate and dihydrovaltrate in *V. wallichii*. [18] Several active degradation products of valepotriates (baldrinal, homobaldrinal, and 11 methoxy viburtinal) and an iridoid ester glycoside designated as valersidatum (isovaleryl glucoside, m.p. 78-80°C) has been identified from *V. wallichii*.

Five compounds of iridoids, lignan and phenylpropanoid glycosides were isolated from the roots of *Valeriana jatamansi* by column chromatography. Their structures were elucidated as 11-methoxyviburtinal, baldrinal, prinsepiol-4-O-β-D-glucoside, coniferin, and hexacosanic acid by spectroscopic analysis.[21] Thirteen new acylated

iridoids, jatamanvaltrates A-M were isolated from the whole plants of *Valeriana jatamansi* (syn. *Valeriana wallichii*). Jatamanvaltrates D and H are the first examples of naturally occurring valepotriates containing an *o* - hydroxybenzoyloxy moiety at C-10.[22]

#### Volatile oil:

The essential oil from root contains calarene, b-bargamotene, a-santalene, a-curumene, xanthorrhizol, valeranone, curcumene, a, b and g-patchoulenes, a-fenchene, patchouli alcohol, maaliol, b-sitosterol, valeranone, maali-oxide, valerenic acid, isovaleric and b-methylvaleric acids (chief constituents), formic, propionic, butyric, palmitic acid and stearic acids, and isovaleryl ester of D(-)ahydroxyisovaleric acid. The oil also contains valerianian, a-pinene, camphene and terpineol.[23, 24] The rhizomes contain citric acid, malic acid, succinic acid and tartaric acid.[25] Other constituents present in root are a-valene, b-bisabolene, b- elemene, b-phellandrene, b-pinene, b-valene, borneol, bornyl acetate, bornyl butyrate, bornyl formate, camphene, limonene, myrcene, caryophyllene.[26] A study revealed that the chemical compositions of the oils show two chemotypes within *V. wallichii*. The type-I was characterized by presence of maaliol (64.3%), viridiflorol (7.2%) and sesquiterpene hydrocarbons (19.2%). The type-II contained patchouli alcohol (40.2%), viridiflorol (5.2%), 8-acetoxy-patchouli alcohol (4.5%) and sesquiterpene hydrocarbons (34.5%). Didrovaltrate was major compound in the dichloromethane extract in both the chemotypes. 11-a- acevaltrate was present in both varieties but was in greater percentage in *V. wallichii* (maaliol type). Isovaleroxyhydroxy didrovaltrate (IVHD) was common in both varieties. Homoisovaltrate is present in *V. wallichii* (patchouli alcohol type), and is absent in *V. wallichii* (maaliol type).[4, 5]

#### Flavonoids;

Two new flavone glycosides, acacetin 7-*O*-  $\beta$ -sophoroside and acacetin 7-*O*-(6''- *O*-a-l-rhamnopyranosyl)- $\beta$ -sophoroside were isolated from the rhizomes and roots of *V. jatamansi* Jones[27]. Plant contains 6-methylapigenin and hesperidin.[ 28] Linarin-isovalerianate is a flavonoid found in *V. wallichii*. [29]

#### Other constituents

Rhizomes and roots contain cyclopentapyrans, acacetin-7-*O*-rutinosides, linarin iso-valerinate, 4-methoxy-8-pentyl-1-naphthoic acid[30], lignan prinsepiol-4- omicron-beta-D-glucoside, coniferin, hexacosanic acid, limonene, choline, chatinine, valerianine, actinidine, tannins and resins. 4-methoxy 8-pentyl-1- naphthoic acid and methyl eicosanoate, cubenol, caryophyllene oxide, cadinol and aristolene are other constituents isolated from this plant.[31, 32] Methanolic extract of *Valeriana wallachi* revealed three types of phenolic acids in which tannic acid (285.90  $\mu\text{g/g}$ ) was present in maximal amount whereas gallic acid and caffeic acid were in trace.[33]

The other constituents of *V. jatamansi* are arcurcumene,  $\alpha$ -,  $\beta$ - and  $\gamma$ -patchoulenes, calarene,  $\beta$ -bergamotene,  $\alpha$  fenchene,  $\beta$ -sitosterol, valeranone, iso-valeric and  $\beta$  methyl-valeric acids. However, composition varies considerably depending on the origin of the plant material. Patchouli alcohol was the main component in the oils of Nepalese valerian. The other components identified in commercially-available rhizomes were  $\gamma$ - patchoulene,  $\alpha$ - humulene,  $\alpha$ - bulnesene, bornyl isovalerate, and two unidentified components with a retention index or 1431 and 1645 respectively. The patchouli alcohol, and  $\beta$ - and  $\gamma$ - patchoulenes, are considered to be characteristic for the oil of *V. jatamansi* as these compounds are not isolated from other *Valeriana* species (Bos *et al.* 1997, Gurung 2009).

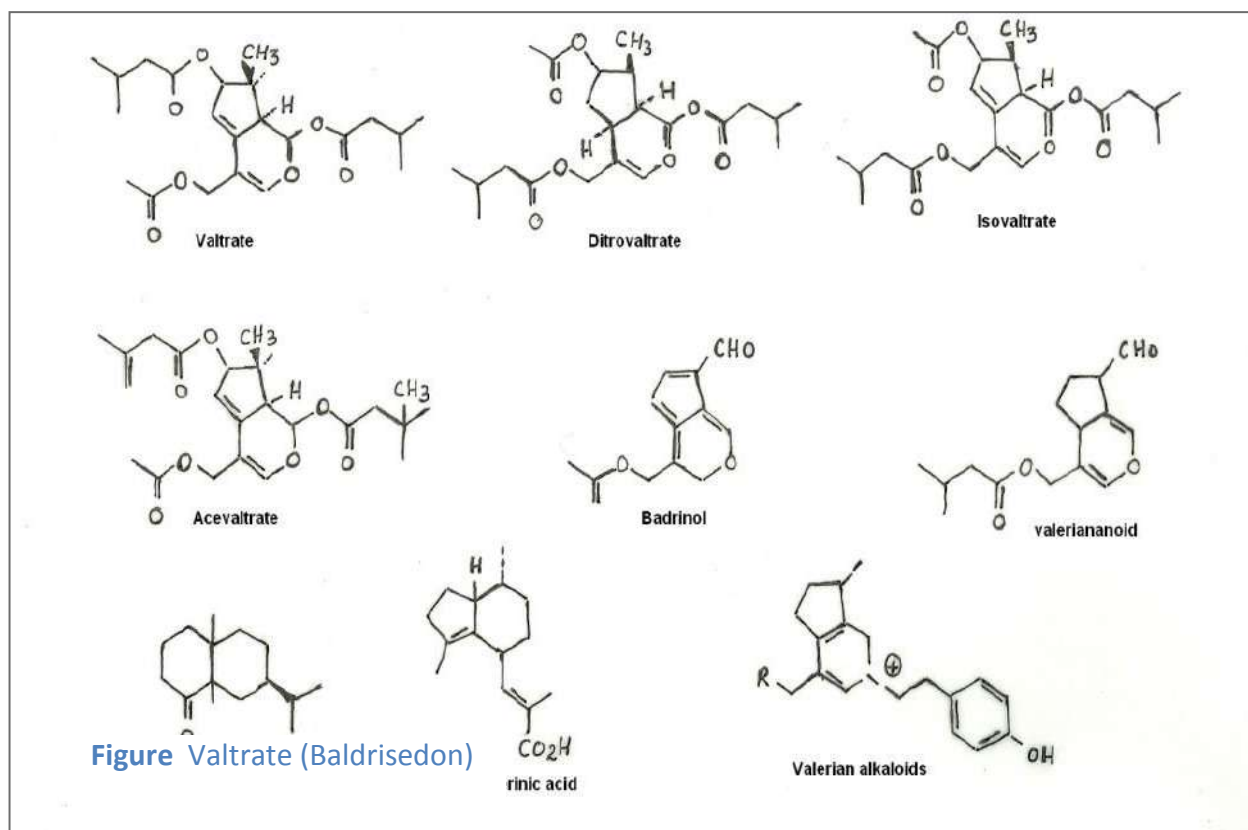


Figure Structure of Valeportriates

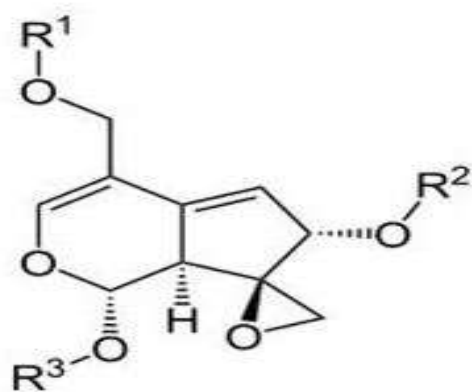


Figure Valeportriate

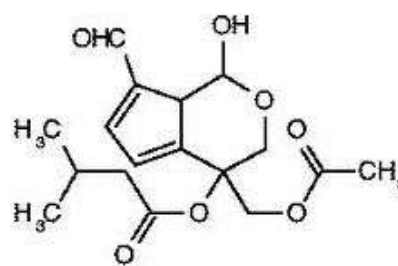


Figure Valtroxal

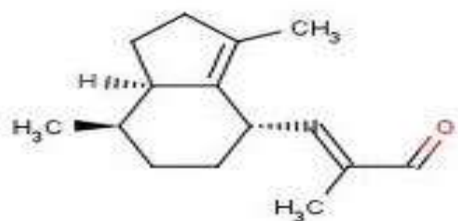


Figure Valerinol

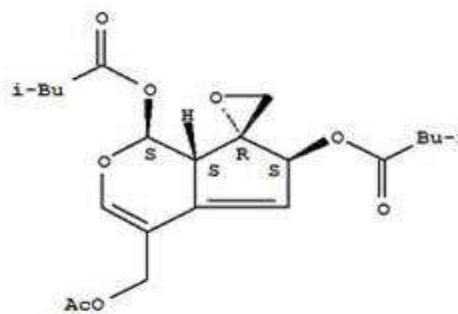


Figure Valtrate

#### ❖ New Iridiod Triester From *Valeriana jatamansi*

A considerable number of studies have been performed on plants of *Valeriana* sp belonging to family Valeriaceae. These investigation have revealed the presence of various chemical constituent. Further investigation has revealed to show the presence of two new iridiod triesters from the root. These are valeriotriate (A)1 and Valeriotriate (B)2.

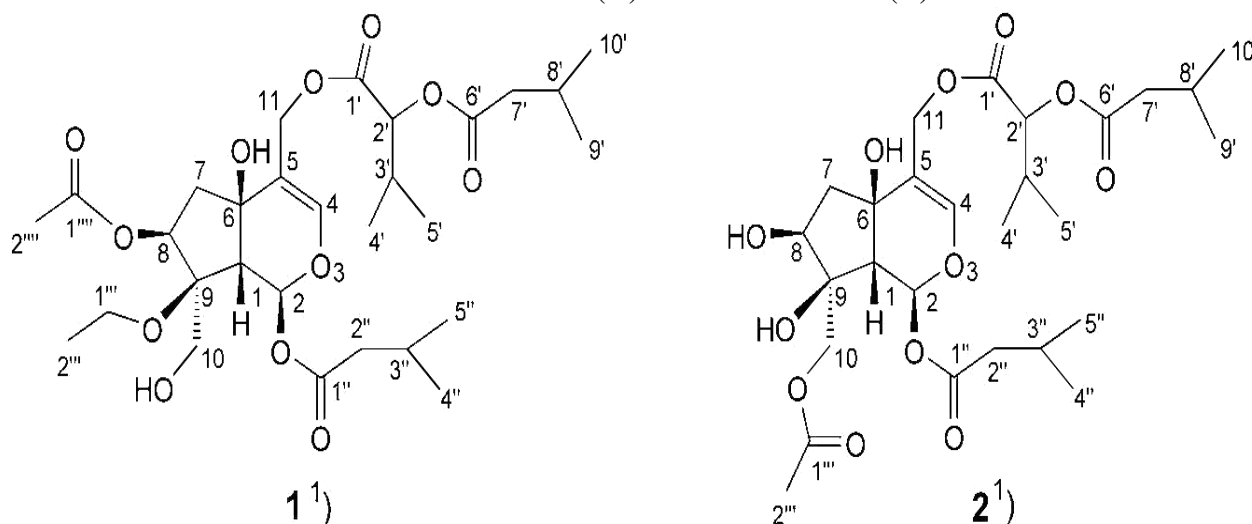


Figure Valeriotriate (A)1 and Valeriotriate (B)2

#### Pharmacological works on *Valeriana*:

The extract is useful in the treatment of stress related disorders in human. It not only significantly ( $p < 0.001$ ) reduces stress and anxiety, but also significantly ( $p < 0.0010$ ) improves depression and enhanced the willingness to adjustment (Bhattacharya *et al.* 2007). The extract showed antibiotic activity against *Micrococcus Pyogenes* var *aureus* and *Entamoeba histolytica*. Indian valerian is also used as an incense, in perfumery, and as an insect-repellent. An extract of the leaves was tested on rats and found to have analgesic action. The extract prepared from the dried rhizome of the herb *Valeriana jatamansi* partially

reverses liver cirrhosis and tissue hyper proliferative response in rat (Prasad *et al.* 2010). Powdered drug, mixed with sugar is used in urinary troubles. A decoction of the drug is reported to be given in Nepal to mothers after parturition, probably as a sedative. The extract is showed antibiotic against *Micrococcus pyogens var. aureus* and *Entamoeba histolytica*. Sugandhawal is also used as incense and as an insect repellent.

❖ **Cardiovascular activity:** The plant extract has coronary dilatating and antiarrhythmic effects in rabbits, mice and cats; valepotriates prevented the appearance of acute coronary insufficiency, abolished vasopressin-induced arrhythmia, provoked a short-lived increase of coronary blood flow, and had moderate positive inotropic and negative chronotropic effects (Petkov *et al.* 1979).

❖ **Gastrointestinal activity:** Valerian is traditionally used in the treatment of intestinal spasms, colic, and “nervous stomach”. Valerian has a bitter flavor, and bitters have historically been used to enhance appetite and digestion. Valerenic acid, valtrate and valeranone exert spasmolytic effects in guinea pig ileum through direct effects on smooth muscle (Wanger *et al.* 1979).

❖ **Anxiolytic or Sedative/Hypnotic activity:** Intraperitoneal injections of valerenic acid, valeranal and whole herb extracts produced significant sedation, ataxia and anticonvulsant effects in mice. Intraperitoneal injections of 100 mg/kg had sedative effects as strong as barbiturates; doses of 400 mg/kg led to death. In comparison with diazepam and chlorpromazine, valerian extract had weak anticonvulsive properties. Valerian root extract (Valdispert) reduced motility and increased thiopental-induced and pentobarbital-induced sleeping time. Even the aroma of valerian root exerted sedative effects in mice (Buchbauer *et al.* 1992).

❖ **Other Neurologic activity:** Valerian did not affect spontaneous ambulation and rearing or approach-avoidance conflict in mice in a water-lick conflict test. On the other hand, valerian and imipramine significantly inhibited immobility induced by a forced swimming test in rats and significantly reversed reserpine-induced hypothermia in mice, leading researchers to conclude that valerian may be a useful antidepressant (Sakamota *et al.* 1992).

❖ **A combination of valerian and lemon balm is effective in the treatment of restlessness and dyssomnia in children:**

Childrens of less than 12 years of age suffering from nervous dysoimesis and restlessness were dosed individually efficacy and tolerability of a combined valerian/lemon balm preparation were investigated. In total, 918 children were evaluated for therapeutic efficacy and tolerability. A distinct and convincing reduction in severity was found for all symptoms in the investigators' and parents' ratings. The core symptoms dyssomnia and restlessness were reduced from "moderate/severe" to "mild" or "absent" in most of the patients. In total, 80.9% of the patients who suffered from dyssomnia experienced an improvement for this symptom and 70.4% of the patients with restlessness improved clearly. For the other listed symptoms the total improvement was 37.8% on average. Both, parents and investigators assessed efficacy as to be "very good" or "good" (60.5% and 67.7%, respectively). The tolerability of Euvegal forte was considered as "good" (in 96.7% of the patients it was judged to be "very good" or "good"). No study medication-related adverse events occurred. In conclusion, Euvegal forte was effective in the treatment of younger children with restlessness and dyssomnia and it was very well tolerated (Muller *et al.* 2006).

❖ The root extracts from *Valeriana jatamansi* shows activity against nematods like *Leishmania* : Valerian antileishmanial activity was reported from the study of its root or rhizome. The methanol and chloroform extracts showed activity against *Leishmania donovani* promastigotes and both promastigotes and amastigotes of *L. major*. The most active fraction, F3, obtained from the chloroform extract, showed IC<sub>50</sub> at ~3–7 µg/ml against both the promastigotes and 0.3 µg/ml against *L. major* amastigotes. When the mechanism of cytotoxicity in *L. donovani* promastigotes was investigated, the ‘hall-mark’ events of morphological degeneration, DNA fragmentation, externalization of phosphatidyl serine, and mitochondrial membrane depolarization indicated that F3 could induce apoptotic death in leishmanial cells. Therefore, a novel and unconventional property of *V. jatamansi* root as a prospective source of effective antileishmanial agents found (Ghosh *et al.* 2011).

❖ *Valeriana jatamansi* as a potential anti-schizophrenic drug: The herb is found to be a potential remedial answer for some mental disorders. Jatamanin 11 – one of the major eleven compounds, shows good interaction with receptor of SNCA protein (alpha-synuclein). This SNCA is encoded by a *SNCA* gene and its aggregation in brains causes neurodegenerative disorders such as Synnucleinopathies (Cookson, 2009). It has been found that Jatamanin 11 shows good interaction with alpha-synuclein protein and it could be a effective drug in curing Lewy body dementia (Bagchi and Hopper 2011).



❖ *Valeriana jatamansi* as tranquilizer and anti-insomnial agent: *Valeriana jatamansi* have found to be medicinally very important in possessing different properties as the potential drug and remedy for various disorders. Some of these are tranquilizer and sedative properties, decrease of Central Nervous System activity there by reducing hypertension, blood pressure and other mental stress and related disorders, reduction of insomnia and sleeping disorders and anti-spasmodic activities (Williams and Lamprecht 2008). Some of the works done in this respect are as follows:-

- i. Valerian (*Valeriana* spp.) has tranquilizing and sedative properties due to its influences on neuromediators such as  $\gamma$ -aminobutyric acid (GABA; Peeters *et al.* 2004).
- ii. There is strong scientific evidence that it decreases CNS activity in mice equal to that of phenobarbital (Hendriks *et al.* 1985).
- iii. Valerian is also effective in treating insomnia and other sleep disorders in humans. The mechanism of action starts with valerenic acid inhibiting the enzyme system that causes the breakdown of GABA in the brain. This respective increase of GABA is associated with sedation and a decrease in CNS activity (Riedel *et al.* 1982; Houghton 1999).
- iv. The components of valerian include valerenic acids, such as monoterpenes and sesquiterpenes, and iridoid glycosides that give the root a sedative and anti-spasmodic activity. In the volatile oil component of valerian, sesquiterpene are responsible for its biological effect (Houghton 1999).
- v. It has been determined that the highest concentration of valerenic acids were recovered in powder capsules, whereas the lowest amount was found in tinctures and teas (Lefebvre *et al.* 2004).
- vi. Another study found a mild tranquillizing effect of a 31.6 mg/kg dose of valeranone in rats subjected to an electric shock avoidance test (Rucker *et al.* 1978).

❖ Insecticidal activity of *Valeriana jatamansi* against mosquitoes: Root extract of *Valeriana jatamansi* exhibited larvicidal and adulticidal activity against different mosquito species. The median lethal concentration of the extract against larvae of *Anopheles stephensi*, *A. culicifacies*, *Aedes aegypti*, *A. albopictus*, and *Culex quinquefasciatus* were found to be 68.1, 42.8, 51.2, 53.8, and 80.6 mg/liter, respectively. But the treatment of this extract against the adult forms of *A. stephensi*, *A. culicifacies*, *A. aegypti*, *A. albopictus*, and *C. quinquefasciatus* were 0.14, 0.16, 0.09, 0.08, and 0.17 and 0.24, 0.34, 0.25, 0.21, and 0.28 mg/cm<sup>2</sup>, respectively. (Dua et al., 2008).

### **Cultivation and Micropropagation:**

Environment for growth:

The plant is found growing on a variety of soils ranging from heavy clay to chalk and lime stone soils. However, the herb prefers loamy soil with a pH ranging from 6.0 to 7.0 and that is rich in organic matter with plenty of moisture but free drainage. *Valeriana* sp is a temperate plant and prefers very cold winters and mild summers for its good growth. The plant flourishes in damp and shaded places with temperatures of 15-25o C. It can be cultivated under apple orchards as a viable intercrop.

Agro-technology

❖ Means of propagation:

The plants can be propagated by vegetative means or through seeds. It can be propagated by pieces of old rootstocks or rhizomes in autumn or spring. The plant may also be propagated from mature seeds collected from the wild.

❖ Collection of seeds:

Fresh robust seeds are collected from a 3-4 year old healthy mother plants. Seed collection is generally done in the month of September. The seeds are very small and light in weight. It should be noted that the seeds lose their viability rapidly and care should be taken to obtain fresh viable seeds. Sufficient care should be taken to store the seeds in a moisture free and clean environment to maintain optimum viability.

❖ Seed treatment and germination:

Germination takes place within a week of sowing in open fields. As the seeds are sown close to the surface, they requires adequate moisture conditions to aid germination.

❖ Propagation by Seeds:

Seeds are collected in October-November from mature and healthy plants. These seeds are air-dried for a few days and kept in a dry cloth or cotton sac and stored in a cool dry place. Before sowing, seeds are pre-treated by immersing in running water for 12 hours to accelerate germination. One part of seed is mixed with five to six parts of nursery soil and sown in a prepared nursery in March-April. Seeds are very small; therefore, 10-15 grams of seeds can be sown in one ropani (5480 sq. ft; 493.2 sq. m). Seeds will germinate after seven

to ten days of sowing. Four to five leaved seedlings are either transferred to polybags or left as such. But seedlings need to be removed from a crowded area to minimize competition.

Seeds can be directly implanted in polybags. For this, polybags are filled with nursery soil and two seeds implanted in each polybag. Seedlings are transplanted to the field after the plant grows to a height of 20 cm (Ghimire *et al.* 2008a).

❖ Propagation by Rhizomes:

Mature rhizomes are cut into small pieces ensuring the presence of a root in each piece and are planted in nursery beds or in polybags in April-May. Rhizomes can be directly planted in the field. The distance between two plants should be at least 30-40cm and between two rows 50-60cm. Regular watering and weeding is needed. Intercropping can be done with potato, buckwheat, and wheat (Ghimire *et al.* 2008a). Rhizomes can be harvested two years after plantation. It has been estimated that 2,500kg of rhizomes can be harvested from one hectare under proper care.

❖ Land preparation and soil work:

After the rock boulders are removed from the field, the land is ploughed to get a good tilth. Deep-rooted weeds should be uprooted thoroughly and clods must be broken during subsequent ploughing.

The land attains a fine tilth after 2-3 rounds of ploughing. FYM is mixed with the soil at 5000 kg/ha or an equivalent of 400 kg/bigha. Beds of convenient size are laid with proper leveling of the soil to raise a nursery. Generally, plain beds with aslight tilt (10-15°C) are found suitable to raise a nursery. However, in the eastern Himalayan ranges, beds with a good drainage system provide better yield as this area has high rainfall. The plants must be planted into rows 40-50 cm apart at 20- 30 cm spacing.

❖ Nursery preparation:

The seeds are sown at a depth of 0.5 cm in the nursery beds. For one bigha of land, 550 g of seeds is required for sowing. Line sowing is mostly practiced at a distance of 20-30 cm between the two rows. The beginning of the rainy season is the optimum time for sowing. The field is given slight irrigation after seed sowing.

❖ Transplanting:

The seedlings should be transplanted to the main field after 6-8 weeks from sowing, at the two-leaf stage, when they are acclimatized. The beds from which the plants are to be transplanted are slightly irrigated.

Transplantation is done from moist beds with a hand hoe or garden fork. The plants should not be pulled out with force or subjected to any intense radiation or heat prior to planting.

Transplantation of the seedlings is done in small pits or trenches dug in the field. The plant is then carefully placed along with the soil from the nursery bed. A light irrigation is done after transplanting.

❖ Vegetative propagation

Vegetative propagation through root cuttings obtained from 2.5-3 year old plants has been found to be more successful than cultivation from seeds. These plants are found to attain maturity with lesser vegetative growth phase than seed-sown crops. Root division should be done early enough in the season to allow the plants to get well established before winter. Treatment of the root splits with Rootex or Keradix (commercial forms of Indole Butyric Acid – IBA) results in faster germination of root cuttings.

❖ Water management:

This crop is sufficiently hardy and requires moderate amount of water for its growth. The field is irrigated for the first time just after seed sowing or after the plantation of saplings or cuttings. Freshly transplanted plants need alternate day irrigation till they are established, then once in a week or every ten days depending upon the moisture in the soil. However, no irrigation is required during the monsoons. Also, water logging conditions should be avoided for the better growth of roots.

❖ Weed & pest control:

Good weed control is essential to achieve good yields of Valerian. The land is kept weed free by hand weeding the plots at regular intervals. Interspaces are harrowed to keep the soil loose. A low ridge of soil is usually raised along the crop row to promote the formation of large rootstocks. To promote higher yield, cutting of floral leaves is carried out in summer. Side dressing with compost/FYM in the second year gives extra nitrogen to the crop and facilitates root growth. Valerian can be rotated or intercropped with nitrogen fixers. Leaf mulching can be adopted in case of seed sown crops for protecting the young plants from

intense solar radiation. Increasing the organic matter content of the soil helps in the improvement of the soil texture. Valerian is a hardy crop and appears to be relatively free from pests and diseases. However, in a few cases, *Rhizoctonia sp* root rot has been observed in plants propagated through root cuttings. A preventive spray of neem or *Artemesia sp* based preparations can be given at the beginning of the cropping season to prevent insect attacks from adjoining cropped fields. The plant based extracts (leaf/root) of valerian can also be used in the preparation of the spraying mixture. This helps repelling leaf feeders including caterpillars/hoppers and sap sucking pests like flies or aphids.

#### ❖ Callus-mediated organogenesis:

##### Materials and methods

- Callus induction

Leaf (ca. 191 cm), petiole (ca. 0.5–0.7 cm) and rhizomes (ca. 191 cm) explants were taken from a 12-month-old single genotype of *V. jatamansi* maintained in the greenhouse, BSI, ERC, Shillong, for callus induction studies. The explants cuttings of 2.0–2.5 cm long were rinsed in running tap water three times and washed in a 2 % (v/v) Tween 20 detergent solution for 15 min. Then the plant materials were surface-sterilized in a solution of 10 % (v/v) sodium hypochlorite for 5 min followed by 0.1 % (w/v) mercuric chloride for 1 min. Finally, the explants were rinsed 3 times with sterilized distilled water. The explants were established in Murashige and Skoog's (1962) basal medium supplemented with 3 % (w/v) sucrose and 0.8 % (w/v) agar-agar (Hi-media, Mumbai, India). The pH of media was adjusted to 5.8 before autoclaving at 15 psi and 121 °C for 20 min. All the explants were cultured on MS medium supplemented with different concentrations of 2,4-D, NAA and IBA (0.25, 0.5, 1.0, 2.0, 3.0 mg/l). Callus cultures were subcultured at 4-week intervals on respective media.

- Regeneration of multiple shoot bud from callus

Randomly selected compact calli were transformed to growth regulator-free MS basal medium to overcome the carryover effect of auxins. To evaluate the effect of growth regulators on the callus potential for shoot regeneration, calli were excised, divided into small pieces (0.590.5 cm) transferred to the regeneration medium for shoot induction. MS medium supplemented with different concentrations of TDZ (0.5, 0.75 mg/l) and kinetin (Kn; 2.0, 3.0 mg/l) alone and in combination with NAA (0.5 mg/l) was used for shoot proliferations from callus in 150-ml culture flasks (Borosil, India). Callus along with the initiated multiple shoot

buds were subcultured on respective regeneration medium after 4 weeks interval to obtain healthy shoots.

- 
- Culture conditions

The cultures were maintained at  $24 \pm 2$  °C and relative humidity (RH) of  $50 \pm 5$  % under 16 h photoperiod with  $30 \text{ } \mu\text{mol m}^{-2}\text{s}^{-1}$  photosynthetic photon flux density (PPFD) provided by cool-white fluorescent light tubes Extraction and HPLC analysis.

- Rooting and acclimatization

Healthy shoots of 4–5 cm were excised and cultured for rooting on MS medium supplemented with different concentrations of auxins viz. indole-3-acetic acid (IAA), NAA and IBA (0.05, 0.10, 0.20 mg/l) in 150-ml culture flasks (Borosil, India). MS medium without growth regulators was used as control. Plantlets with well-developed roots were removed from the culture medium, washed gently under running tap water, and transferred to root trainers containing garden soil and acclimatized under greenhouse condition ( $24 \pm 2$  °C temp. and  $80 \pm 5$  % RH) without use of any organic fertilizers.

#### Results and discussion

- Callus induction

The disinfection treatment used was efficient for in vitro establishment with approximately 94 % of the explants remaining aseptic. In *V. jatamansi* callus induction varied significantly depending on the explant type. Among different explants used, rhizomes have the highest callus induction potential followed by leaf. Rhizome explants started swelling within 6–8 days, whereas leaf and petiole materials started within 10–12 days of inoculation. MS basal medium without growth regulators exhibited no callus proliferation. All the calli in the growth regulators supplemented media were observed to be initiated from the cutting edge of the explants. The induced calli were fast growing, yellowish green and compact. The callus induction frequency was found optimum in rhizome explants on media supplemented with 0.5 mg/l 2,4-D (86 %) followed by 0.5 mg/l NAA (75.8 %). In our study, 0.5 mg/l 2,4-D was the best auxin responsible for obtaining the vigorous and compact callus from rhizome ( $0.23 \pm 0.06$  g), leaf ( $0.17 \pm 0.06$  g) and petiole ( $0.13 \pm 0.03$  g) explants.

Compact calli are important in the in vitro cultures as they have ability for organogenesis. They are more efficient to develop chlorophyll than friable calli from the same explants; this might be due to the chloroplast development and integrity favored by cell aggregation (George and Sherrington 1984).

- Shoot regeneration from callus

The regenerative ability of proliferated compact calli was studied by the application of cytokinins alone and in combination with auxin. After 2 weeks of culture, most of the calli turned green in order to give response towards regeneration of plantlets. Shoot primordia appeared after 2 weeks in the regeneration medium. MS medium supplemented with 0.75 mg/l TDZ in combination with 0.5 mg/l NAA showed the highest regeneration frequency (88.6 %) and produced the highest number of shoot buds ( $15.20 \pm 0.20$ ) capable of growing into single plants.

- Rooting and acclimatization

In vitro shoots, regenerated from shoot clusters proliferated on multiple shoot induced medium and callus regeneration medium were separated and used for the rooting experiments. Rooting initiated after 2 weeks in all cultures including control. But, the response of rooting (%), number and length of roots were achieved significantly higher when cultured with auxin-supplemented media. Among different auxins used, NAA (0.05, 0.1 mg/l) and IAA (0.1 mg/l) were effective in producing longer and healthy roots with 100 % response. IBA showed significantly lower root-inducing potential both in response to root numbers and root length. MS medium fortified with 0.1 mg/l NAA produced the highest number of roots ( $17.30 \pm 2.01$ ) followed by 0.05 mg/l NAA ( $12.40 \pm 1.20$ ). NAA when used as low concentrations was considered as an effective rooting hormone in many plant systems (Mao et al. 1995; Sanches-Gras and Calvo 1996; Rout et al. 2000). However, MS basal medium without auxins produced significantly lower number of roots and were not found healthy for hardening in greenhouse. There are many reports on the microshoots of various medicinal plants rooted on only MS medium without the growth regulators (Christine and Chan 2007; Mao et al. 1995). Explants having a functional rooting system are more likely to survive transition to greenhouse. Roots were washed thoroughly before being transferred to root trainers.

Micropropagated plantlets with well-developed root system were successfully acclimatized in greenhouse condition, in root trainers containing garden soil with a survival frequency of 100 %. The in vitro-derived plants were phenotypically similar to the parental stock and no morphological abnormalities have been observed in the (Mao et al. 1995; Sanches-Gras and Calvo 1996; Rout et al. 2000). Also, IAA was reported to enhance the root formation in case of *Hedeoma multiflorum* (Koroch et al. 1997) and *Woodfordia fruticosa* (Krishnan and

Seeni 1994). However, MS basal medium without auxins produced significantly lower number of roots and were not found healthy for hardening in greenhouse. There are many reports on the microshoots of various medicinal plants rooted on only MS medium without the growth regulators.

Fig. 1 Callus induction and regeneration of plantlets from callus in *V. jatamansi* Jones. a 8-week-old vigorous callus (bar 10 mm) induction from leaf explant on MS medium with 0.5 mg/l 2,4-D.

b 8- week-old vigorous callus induction (bar 10 mm) from rhizome explant on MS medium with 0.5 mg/l 2,4-D.

c, d Regenerated plantlets (bar 15 mm) from callus on MS medium with 0.75 mg/l TDZ and 0.5 mg/l NAA.

e 8-week-old in vitro-raised plantlet with a healthy root system.

f Acclimatized plants in the greenhouse condition and

g 1-year-old established plants.

### **Sustainable Management:**

#### **❖ Harvest Time and Method:**

Rhizomes should be collected only after the plant attains maturity i.e. from September to November. A very good indication of maturity is when the leaf's colour turns pale-yellow. Care should be taken while harvesting, which should follow a selective collection of matured rhizomes, leaving some part in the ground to facilitate vegetative propagation and replanting of younger ones. Plants

should be thoroughly shaken to allow seed dispersal. Harvesting can be done with the help of a metallic axes (*kuto*) without damaging younger plants and other associated species.

#### **❖ Harvest Intensity:**

The collection area should be divided into four plots and

harvesting should be done on a rotational basis. Only mature plants should be

harvested, even if rotational system is followed. It is recommended to leave 25-40

per cent of rhizomes behind to promote vegetative reproduction. In case of cultivated Sugandhawal, farmers often remove all rhizomes and re-transplant after composting the soil.



❖ Post Harvesting and Storage:

Valerian oil is extracted from dried rhizomes of *V. jatamansii*. Content and quality of Valerian oil decreases if the rhizomes are not stored properly; therefore, care should be taken during storage. Rhizomes are thoroughly washed in water and suspended particles removed. Washing is generally done by rinsing the rhizomes in spring water. Rhizomes are dried in the shade until they are free of moisture, and then kept in jute bags and stored in a cool dry place for later use.

❖ Oil extraction process of *Valeriana jatamansi*:

The extraction of essential oil involves steam distillation. Distillation is the separation of components from a mixture of two or more liquids by virtue of differences in their vapour pressure. There are three basic types of oil distillation methods: a) hydro distillation, b) wet steam distillation, and c) dry steam distillation. The charge (technical term used for the material that has to be distilled, Valerian root in this instance) is totally immersed in boiling water in the hydro-distillation process. Water is boiled below the charge and wet steam passes through the plant material in wet steam distillation; charge and water being separated by a porous grid. Dry steam distillation is the most advanced type of distillation where steam is supplied from a separate boiler and pressure in the vessel can be maintained at all times. Operators of wet steam distillation units need to understand the loading and unloading of plant material, time taken for extraction, and maintain the heat—which is relatively easier. Extraction using dry steam distillation method requires competency because the unit is sophisticated and operators have to maintain steam pressure at all times during the distillation process along with other basic skills needed to extract oil from a wet steam distillation unit (Pyakurel and Baniya 2011).

Distillation unit (DU) consists of a vessel, boiler, condenser, receiver (oil separator), and a steam pipeline with valves. DU manufactured from stainless steel or mild steel can be used. While the former is more expensive than the latter, the yield and quality of oil is better. Both types are fabricated in Nepal but sophisticated units are still imported from India. A stainless steel DU is expected to last more than 20 years whereas a mild steel DU lasts about 10 years. *Valeriana* oil is generally extracted from stainless steel distillation units. The capacity of the DU depends on the volume of raw material, accessibility and economic feasibility. However, for *Valeriana* oil extraction, a distillation unit with a capacity of 1,000L is generally used commercially. This unit can distill nearly 300kg of rppt at one time (Pyakurel and Baniya 2011).

### ❖ Processing

Sugandhabal roots are sealed inside the DU vessel. Wet steam DU consists of an attached boiler in the lower part of the vessel where water is transformed into steam after heating. There is a separate boiler in a dry steam DU where steam passes from a pipe to the vessel. The boiler is heated using wood fuel. It takes about two to three hours for the fruits to be macerated. Steam charged with *Valeriana* oil is passed from the vessel to the condenser through the lid. The charged steam is cooled in a condenser that contains parallel tubes or zigzag pipes for steam flow, with cold water flowing around the tubes or pipes. Distillation process lasts for about five to seven hours. Care should be taken towards maintaining the temperature. The quality of *Valeriana* oil deteriorates if the temperature exceeds 100°C. The vaporized water and essential oil are transformed into liquid which flows from the condenser to an oil separator. *Valeriana* oil is lighter than water and floats at the top in the oil separator. The oil is separated from water and foreign particles removed by filtration with a clean cotton or muslin cloth. The amount of water present in the essential oil is separated twice, once during the first extraction and then during the transfer to the container. Oil is stored in a high-density polythene container or epoxy coated metal or aluminium containers. Essential oil should be stored in a dark and cool warehouse. Most essential oil deteriorates through oxidation and polymerisation upon prolonged exposure to air and light. Without such precaution, the essence becomes less intense, grows darker and more viscous, develops a bleaching effect, and eventually changes into a brown, odourless resin (Pyakurel and Baniya 2011).

#### **Whole distillation process can be summarised as follows:**

Procurement of Sugandhabal roots, firewood, packaging and labelling materials



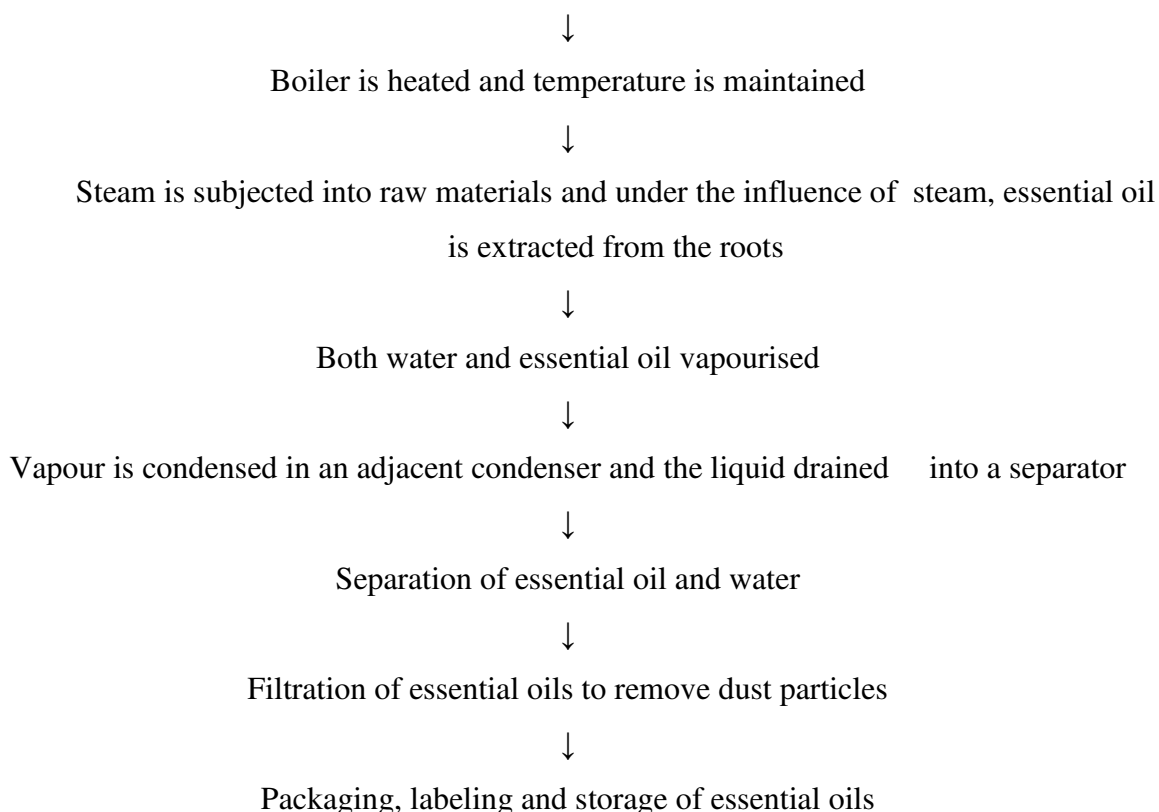
Storage of purchased materials with care



Raw materials are put in the vessel



Water is put in the boiler



### **Conservation Status and Royalty:**

The global status of Sugandhawal is not known. It is considered to be vulnerable in Nepal (CAMP 2001). Commercial collection of rhizomes for trade poses great threat to its sustainability in the wild. It has been incorporated in the protection list of the government of Nepal and has been prioritised for conservation and economic development (GoN/MOFSC/DPR 2006). The Department of Forest, as per Forest Act 1993 and Forest Regulation Act 1995, banned the export of raw Sugandhawal. However, large amounts of unprocessed air-dried rhizomes are illegally exported to India (Olsen 2005). Valerian oil can be exported after proper certifications and permissions from Department of Forests. Dried rhizomes of Sugandhawal have a royalty of Rs.15 per kg.

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## **Dung Beetles of Dooars: A Subserviant to Humankind**

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### **ABSTRACT:**

Dung beetles particularly the coprophagous or scavenger beetles (Coprini : Scarabaeidae) play a remarkable role in agriculture. By burying and consuming dung, they improve nutrient recycling and soil structure. They also protect livestock, such as cattle, by removing the dung which, if left, could provide habitat for pests such as flies. Many countries have introduced the creature for the benefit of animal husbandry. In developing countries, the beetle is specially important as an adjunct for improving standards of hygiene. The Dung Beetles Release Strategy Group concluded that it also results in the reduction of greenhouse gas emissions from the agricultural sector. Like many others, these insects too have medicinal value. Unfortunately knowledge on the Indian scavenger beetles is still poor. Present work is intended to generate primary data on such beetles and accordingly reports 19 species under 6 genera from the tropical forests of Dooars, namely Buxa Tiger Reserve (BTR), Jaldapara Wildlife Sanctuary (JWLS), Gorumara National Park (GNP) and Chapramari Wildlife Sanctuary. Of these, 1 species is recorded new from India, 4 from West Bengal, 2 each from BTR, GNP and CWLS and 8 from JWLS. Out of the total collection 3 species are recorded as disjunct or endemic to India. The dominant species are *Onthophagus dama* Fabricius, *O. falcifer* Harold and *O. tragus* Fabricius and *Catharsius molossus* (Linnaeus) which should be exploited in the pasture enrichment. Their distribution is mostly during monsoon (73.68%), followed by premonsoon (63.15%) and postmonsoon (42.10%). Of the recorded species 5 are consistently present throughout the year. Analysis of their zoogeographical distribution reveals that the fauna is mostly Oriental. Unlike other countries India do not require to import any such beetles because of their high endemism. Only need of the hour is to utilize this potential bioresource in the interest of human society.

**Key words:** Dung beetles, Reserve forests, Dooars, Bioresource.

## INTRODUCTION:

If we ask someone to make a list of beneficial insects, he or she would most likely think of pollinators like honeybees or may be predators such as dragonflies. We presume that very few people would consider including dung beetles on their list, despite their ecological and economic value. Livestock farmers tend to be well-diversified managers of farm ecosystems. They are well aware of the importance of maintaining a quality and healthy pasture for their animals that consists of soil, vegetation, moisture, insects and nutrients. Within that system there is a particular insect worth its weight in gold. This valuable creature is the dung beetle whose purpose in life is to break down animal manure and move the basic nutrients and organic matter into the subsoil. While it might not sound like a glamorous job, it is important in maintaining a healthy pasture ecosystem.

Scarabaeidae includes about 91% of all scarabaeoids (Coleoptera) and include about 600 genera and 27,800 species worldwide (Ratcliffe and Jameson, 2013). Of these, 7,000 are known species of dung beetles (Coprinae). Members of other scarab subfamilies (Aphodiinae and Geotrupinae) are also called dung beetles. However, instead of forming balls, they excavate a chamber under a pile of dung that is used during feeding or for depositing eggs. Dung beetles thrive throughout the world except Antarctica, and occur in a variety of habitat types including grasslands and forests. These coprophagous beetles eat poop as adults and as larvae. Many dung beetles roll the dung into a ball that is used for food or to create a “brooding ball”, in which the females lay eggs. After hatching the larvae feed on the dung. They can be grouped into three main categories. 1) “Tunnelers” bury their brooding balls in the ground, often near the original dung. 2) “Rollers” transport the dung balls farther away from the original dung, often in remarkably straight lines, before they bury it (Plate I). In doing so they navigate using the Milky Way. Dung beetle *Scarabaeus zambesianus* Péringuey, use the stars to orient themselves! (Dacke *et.al.*, 2003, 2013; Milius, 2003; Roach, 2003). The discovery is the first proof that an animal can use polarized moonlight for orientation apart from humans. New research confirmed that at least one species of African dung chafer, *Scarabaeus satyrus* Boheman, uses the Milky Way as a guide to steering its dung ball home. The researchers placed tiny hats on the dung beetles, effectively blocking their view of the heavens, and found that they could only wander aimlessly without being

able to see the stars. 3) “Dwellers” brood their young within the dung, rather than in separate brooding balls.

Dung chafers with different behaviour have different effects on ecosystem services. The maintenance of ecosystem services by them depends on a diverse assemblage of dung beetle species. They are important in nutrient cycling. By breaking poop into smaller pieces and moving it underground, these tumblebugs facilitate decomposition and make the nutrients available to other organisms (Nichols *et.al*, 2008). Studies have found that many soil nutrients are increased when dung beetles are present. They also increase nitrogen mineralization, the process by which nitrogen is converted from an organic to an inorganic form, making it available for use by plants and subsequently, the rest of the food web.

Tunnelers are especially important for bioturbation i.e. the mixing and redistribution of sediments, the process affects soil moisture and soil aeration.

By increasing nitrogen availability and facilitating decomposition, nutrient cycling and bioturbation, dung beetles can increase plant productivity. Many studies have found that dung beetles increase plant biomass, nitrogen content and grain production. These scarabs may also contribute to plant productivity by dispersal of seeds found in dung, which can lead to increased plant recruitment. Some species of dung beetles are important pollinators of decay-scented flowers. Such beetles can reduce the abundance of parasites and flies that breed in dung. After laying their eggs in the ground, the larvae hatch and eat gastrointestinal parasites found in the dung, and their tunneling action aerates the soil. These processes interrupt the life-cycle of the parasites. Farmers and ranchers may spend hundreds of millions of dollar each year to control internal parasites while the dung beetles destroy parasites at no charge. The dung burial activity are remarkably disrupted by land use changes from natural forest to open agricultural area. Their presence elevated about 53% of the total dung removed and reduced about 83% and 63% of fly population and richness, respectively (Shahabuddin, 2011).

Many countries introduce these dung beetles for the benefit of animal husbandry. The American Institute of Biological Sciences reports that dung beetles save United States’ cattle industry an estimated US \$ 380 million annually through burying above-ground livestock (Losey and Vaughan, 2006). The Commonwealth Scientific and Research Organization (CSIRO) commissioned the Australian Dung Beetle Project (1965-1985) and introduced 23



species of *Copris* Geoffroy, *Onitis* Fabricius, *Onthophagus* Latreille, etc. from South Africa and Europe. This caused qualitative improvement of Australian cattle pastures, along with a reduction in the population of pestilent bush-flies by around 90% ((Bornemissza, 1976). New Zealand too imported 11 species so as to improve pasture soils. Like many others, these insects too have medicinal value. They (dried) called *Qianglang*, are used in Chinese herbal medicine. Their role for the cure of 10 diseases is on record in the ‘Insect Section’ of the Compendium of Materia Medica. In Isan, Northeastern Thailand, the local people famously eat many different kinds of insects including the dung beetles.

The sacred scarab of ancient Egypt (*Scarabaeus sacer* Linnaeus) found in many paintings and jewelry, is a dung beetle. Egyptian cosmogony includes the scarab beetle rolling its ball of dung with the ball representing the Earth and the beetle the Sun. The six legs, each with five segments (total 30), represent the 30 days of each month. An interesting member of this subfamily is *Aulacopris maximus* Matthews, one of the largest dung beetle species found in Australia, reaching as many as 28 mm in length. The Indian scarabs *Heliocopris* Hope and certain *Catharsius* Hope species make very large manure balls and cover them with a layer of clay, which becomes so hard when dry that the balls were once thought to be old stone cannonballs.

The subfamily Scarabaeinae is a large insect group exhibiting extreme diversity in size (2 mm to 60 mm), colour and shape. Most of them are black, but a few more flamboyant species come in brown to red and brilliant shades of green or gold. They are usually round with short wing covers (elytra) that expose the end of the abdomen. Just below the forehead, their exoskeleton forms a rounded shield-like clypeus, which covers the mouthparts. Some male members possess 1 or 2 impressive horns, which they use as weapons to fend off other male competitors. The front legs usually have serrated edges, used for powerful digging. Scarabs are distinguished from other beetles by appearance of their antennae, which are segmented and end with a plate-like oval club of 3 to 7 expansible leaves. These lamellate antennae create a large surface area for detecting odors. The dung chafers form manure into a ball using its scooper like head and paddle shaped antennae.

Some dung beetles are surprisingly strong. Even a small ball of fresh dung can be hefty to push, weighing 50 times the weight of the determined dung beetle. Male dung beetles need exceptional strength also for driving out the male competitors. The individual strength record goes to a male *Onthophagus taurus* Schreber dung beetle, which pulled a load equivalent to

1,141 times its own body weight. In human terms, that would be like a 150lb person pulling 80 tons!

Phenotypically plastic trait complexes such as polyphenism, account for the bewildering diversity of forms and behavior and play a vastly unexplored role in the evolution of morphological and behavioral novelties. Males of many species of dung chafers of the genera *Onthophagus* and *Catharsius* express exuberant secondary sexual trait such as horns. These horns develop in response to larval feeding conditions and are used as weapons in aggressive interactions and also to gain access and to mate with the female. In many species, horn expression is discontinuous, and male populations are composed of two alternatives, discrete shapes. Precisely, many species exhibit polyphenism for male morphology. Both horned and hornless males of *Onthophagus taurus* are indeed able to recognize the presence or absence of other male siblings and respond by adjusting their investment into cooperative versus mate-securing behaviours (Moczek & Nijhout, 2003). Such condition-dependent paternal assistance may represent a mechanism by which males minimize fitness in a social environment composed of variable degrees of male-male competition for females. Facultative parental investment is likely to evolve when a patch and ephemeral resource environment favours cooperation, while at the same time intraspecific mating competition selects for behaviours that secure mates and breeding opportunities (Trumbo and Fernandez, 1995).

Many dung beetles are good parents. In most cases, child rearing responsibilities fall on the mother, who constructs the nest and provisions it with food for her young. But in certain species, both parents share child care duties to some degree. In the genera *Copris* and *Onthophagus*, the male and female work together to dig their nests.

A recent study showed the dung beetles use their poop balls to cool off. Around noon, when the sun is at its peak, they will routinely climb atop their dung balls to give their feet a break from the hot ground. The scientists tried putting tiny, silicon booties on them and they discovered the beetles wearing shoes would take fewer breaks and push their dung balls longer than the beetles that were barefoot. Thermal imaging also showed that the dung balls were measurably cooler than the surrounding environment, probably because of their moisture content.

## RETROSPECT:

Indian works on these highly precious groups may at best be categorized into 2 subsections one on the taxonomy and the other on the ecology. The taxonomic study particularly during the post independence era is of Chandra & Ahirwar (2005), who reported 22 species under 9 genera from Bandhavgarh National Park, Madhya Pradesh. Sewak (2006) also dealt 60 species under 11 genera from Thar Desert, Gujarat. On the other hand North east India precisely Arunachal Pradesh received some attention of Sewak (2006). He ( op.cit.) recorded 34 coprine species. In recent past Sarkar *et. al.* (2010) reported 7 coprine species from Buxa Tiger Reserve that included 4 species namely *Catharsius javanus* Lansberge, *Copris sarpedon* Harold, *C. doriae* Harold and *C. corpulentus* Gillet as new records from India. Sabu *et. al.* (2006) so far is the only contributor who studied the diversity, guild structure and succession of dung beetles associated with Indian elephant dung in a deciduous forest site in Western Ghats, India.

Above speaks of our very poor knowledge on the Indian dung beetles. Only need of the hour is to generate base line data and to utilize those potential bioresource in the interest of human society.

It is with this background present study is intended to generate primary data on the dung beetles of the protected areas of Dooars, the tropical rain forests of Eastern India, as a part of Megadiversity Hotspot sector.

## MATERIALS AND METHODS:

Both extensive and intensive surveys were conducted during 1993-2011 in different beats under different ranges of BTR, JWLS, GNP and CWLS. Field visits were made in every month of each calendar year during the period of survey (except 15<sup>th</sup> June to 15<sup>th</sup> September when the forest remains closed for rejuvenation). For collection of scarabs sweep nets, bush beating and collection in inverted umbrella, hand picking techniques, pit fall traps and UV light traps were used. Dung of various animals was also examined to make collections.

Samples after collection were killed in chloroform and preserved in 70% alcohol in glass vials. Necessary data regarding date of collection, locality, etc were noted in a note book in the field. The samples were then brought to the laboratory where stretching, pinning and labeling is done as per the guidelines laid down by Zoological Survey of India (1986).

All materials are in the collection of Entomology Laboratory, Department of Zoology, University of Calcutta, Kolkata, India.

The collected samples and their respective male genitalia were studied under Stereozoom Binocular Microscopes Zeiss SV6, SV11 and Olympus SZ 30. Photographs (dorsal habitus) were taken by a digital camera attached to the microscopes.

Identification of the coprine samples were done following Arrow (1931). In the process, several other literatures viz. Jameson and Ratcliffe (2002), Ratcliffe and Jameson (2013) were consulted to conclude on their current status. Taxa, status of which thus determined is also compared with the type specimens deposited in the collection of Zoological Survey of India, Kolkata.

### RESULTS AND DISCUSSION:

During our survey in the above referred tropical forests in the confluence of Eastern Himalayas, we sampled a total of 19 species under 6 coprine genera (Table:1; Plates: II,III & IV). Of the recorded genera, *Onthophagus* Latreille, *Catharsius* Hope and *Copris* Geoffroy are the dominant groups.. At the species level, *Onthophagus dama* Fabricius, *O. falcifer* Harold and *O. tragus* Fabricius and *Catharsius molossus* (Linnaeus) seem to be the dominating members. Of these both the species, *O. dama* and *O. tragus* show wider distribution within the forests.

Of these, 1 species, *Heliocopris tyrannus* (Thomson) is recorded new from India, 4, *Catharsius javanus* Lansberge, *Copris corpulentus* Gillete, *C. doriae* Harold, *C. sarpedon* Harold from West Bengal and 2, *Catharsius capusinus* Fabricius and *Onitis subopacus* Lansberge from BTR and all other species collected from rest of the forests. Out of the total collection 3 species, *Gymnopleurus sinuatus* Olivier, var. *assamensis* Watson, *Onthophagus falcifer* Harold and *O. triceratops* Arrow are recorded as disjunct or endemic to India (Table:1). Their seasonal distribution is mostly during monsoon (73.68%), followed by premonsoon (63.15%) and postmonsoon (42.10%). Of the recorded species 5 are consistently present throughout the year (Table:1). Analysis of their zoogeographical distribution reveals that the fauna is mostly Oriental (Table:1). An additional achievement of the study is the record of 7 species of *Onthophagus* which may be considered as a potential bioresource for Indian Cattle and Pasture Industry.

The generated data speaks high of BTR in terms of species richness and therefore calls for necessary conservation measure.

**Table 1: Distribution of the recorded taxa**

Taxa		Distribution				
		Within Reserve Forests	India	Global	Zoogeographical	Seasonal
1.	# ●■ <i>Catharsius birmanensis</i> Lansberge	Rajabhatkhawa, Raimatang (BTR); Gorumara (GNP); Chapramari (CWLS)	Sikkim, West Bengal	India, Bhutan, Myanmar	Oriental	Monsoon, Postmonsoon
2.	* <i>Catharsius capusinus</i> Fabricius	Rajabhatkhawa (BTR)	Bihar, Kerala, Orissa, Tamilnadu, West Bengal	India, SriLanka	Oriental	Premonsoon
3.	** <i>Catharsius javanus</i> Lansberge	Damanpur (BTR)	Assam, West Bengal	India, China, Indonesia, Malaysia	Oriental	Premonsoon
4.	<i>Catharsius molossus</i> (Linnaeus)	Rajabhatkhawa, Raimatang, Panbari, Jayanti, Bhatanghat (BTR)	Andaman, Assam, Bihar, Himachal Pradesh, Karnataka, Kerala,	India, SriLanka	Oriental	Premonsoon, Monsoon, Postmonsoon

			Madhya Pradesh, Maharashtra, Orissa, Sikkim, Uttarakhand, West Bengal			
5.	<b>**</b> <i>Copris corpulentus</i> Gillet	Cheko (BTR)	Assam, Gujarat, West Bengal	India, Myanmar, Vietnam	Oriental	Postmonsoon
6.	<b>**</b> <i>Copris doriae</i> Harold	Rajabhatkhawa (BTR)	Assam, Manipur, West Bengal	India, Indonesia, Malaysia, Myanmar	Oriental	Premonsoon
7.	<b>#</b> <i>Copris magicus</i> Harold	South Rydak (BTR), Malangi (JWLS)	Assam, Manipur, Nagaland, Sikkim, West Bengal	India, China, Myanmar, Vietnam	Oriental	Premonsoon, Monsoon
8.	<b>**</b> <i>Copris sarpedon</i> Harold	Sankosh (BTR)	Assam, Arunachal Pradesh, Punjab, Uttarakhand, Uttar Pradesh, West Bengal	India, Nepal, Thailand	Oriental	Monsoon
9.	<b>♠#</b> <i>Gymnopleurus</i>	Rajabhatkhawa ,	Karnataka, Madhya	India	Oriental	Premonsoon, Monsoon

	<i>sinuatus</i> Olivier, var. <i>assamensis</i> Watson	Nimati, South Rydak (BTR); TEC (JWLS)	Pradesh, Maharashtra, Tamilnadu, West Bengal			
10.	+ <i>Heliocopris</i> <i>tyrannus</i> (Thomson)	Rajabhatkhawa (BTR)	West Bengal	India, Indonesia, Malaysia, Myanmar	Oriental	Monsoon
11.	*# <i>Onitis</i> <i>subopacus</i> Lansberge	Garam, Cheko, Poro, Rajabhatkhawa , Jayanti (BTR), Madarihat (JWLS)	Andhra Pradesh, Assam, Bihar, Kashmir, Madhya Pradesh, Uttarakhand, West Bengal	India, Malaysia, Myanmar, SriLanka, Thailand	Malayan, Oriental	Premonsoon, Monsoon, Postmonsoon
12.	# <i>Onitis virens</i> Lansberge	Rajabhatkhawa , South Bholka, Jayanti (BTR); Jaldapara (JWLS)	Assam, Bihar, Kerala, Madhya Pradesh, Maharashtra, Tamilnadu, Uttarakhand, West Bengal	India, China, Myanmar, Vietnam	Oriental	Premonsoon, Monsoon
13.	<i>Onthophagus</i> <i>armatus</i> Blanchard	Jayanti (BTR)	Assam, West Bengal	India, Indonesia, Myanmar,	Oriental	Postmonsoon

				Philippines		
14.	<i>Onthophagus bison</i> Boucomont	South Bholka (BTR)	West Bengal	India, Myanmar	Oriental	Monsoon
15.	# <i>Onthophagus bonasus</i> Fabricius	South Bholka, Rajabhatkhawa (BTR); Dhoidhoighat (JWLS)	Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Tamilnadu, Uttarakhand, West Bengal	India, Cambodia, Myanmar, Pakistan, SriLanka, Thailand, Vietnam	Oriental	Premonsoon, Monsoon
16.	#●■ <i>Onthophagus dama</i> Fabricius	Rajabhatkhawa, Raimatang, Damanpur, Hatipota, Newland, Cheko, South Rydak, Nimati, Poro, Garam (BTR); Kunjanagar, Malangi, Mantharam (JWLS), Gorumara (GNP); Chapramari (CWLS)	Bihar, Karnataka, Madhya Pradesh, Maharashtra, Sikkim, Tamilnadu, Uttarakhand, West Bengal	India, Bhutan, Nepal, SriLanka	Oriental	Premonsoon, Monsoon, Postmonsoon



17.	♠ <i>Onthophagus falcifer</i> Harold	Rajabhatkhawa , Raimatang, Garam, Damanpur (BTR)	Sikkim, West Bengal	India	Oriental	Premonsoon, Monsoon, Postmonsoon
18.	# <i>Onthophagus tragus</i> Fabricius	Rajabhatkhawa , South Bholka, Damanpur, Poro, Garam, Jayanti, South Rydak (BTR); Bania, Hollong, Jaldapara, NWC (JWLS)	Maharashtra, West Bengal	India, China, Indonesia, Myanmar, Vietnam	Malayan, Oriental	Premonsoon, Monsoon, Postmonsoon
19.	♠ <i>Onthophagus triceratops</i> Arrow	Rajabhatkhawa , Nimati (BTR)	Assam, Gujarat, West Bengal	India	Oriental	Monsoon

\* New record from BTR

# New record from JWLS

● New record from GNP

■ New record from CWLS

\*\* New record from West Bengal

+ New record from India

♠ Endemic to India

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**Plate I : A coprine with its dung ball**



**Plate II : Recorded Dung Beetles**



♂

*Catharsius birmanensis* Lansberge



♀



♀

*Catharsius capusinus* Fabricius



♂

*Catharsius javanus* Lansberge



♂

*Catharsius molossus* (Linnaeus)



♀



♂

*Copris corpulentus* Gillet



♂

*Copris doriae* Harold



♀

*Copris magicus* Harold



**Plate III : Recorded Dung Beetles**



♀

***Copris sarpedon* Harold**



♂

***Gymnopleurus sinuatus* Olivier, var. *assamensis* Watson**



♀



♀

***Heliocopris tyrannus* (Thomson)**



♂

***Onitis subopacus* Lansberge**



♀



♂

***Onitis virens* Lansberge**



♀



♀

***Onthophagus armatus* Blanchard**

**Plate IV : Recorded Dung Beetles**



♀

***Onthophagus bison* Boucomont**



♀

***Onthophagus bonasus* Fabricius**



♂



♀

***Onthophagus dama* Fabricius**



♂



♀

***Onthophagus falcifer* Harold**



♂



♀

***Onthophagus tragus* Fabricius**



♂

***Onthophagus triceratops* Arrow**



## **Standardization of Pretreatment Techniques for the Study of Arbuscular Mycorrhizal Fungal Association with an Important Medicinal Plant of Darjeeling**

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### **ABSTRACT:**

The present study was done with the aim to standardize the cold treatment for the observation of mycorrhizal fungal association with medicinal plant of local Darjeeling. This reflects an easy manipulation technique which is eco-friendly and cost effective during studying their VAM fungi. Standardization proved that 15 to 20% KOH for treatment of 3 days as cold treatment was good for the specimens to study the Arbuscular mycorrhizal association in *Drymaria cordata* locally called Abijal/Obijal.

**Key words:** Standardization of Root colonization, VAM, Abijal, Darjeeling

### **INTRODUCTION:**

The term mycorrhiza is used to describe the symbiotic association between a fungus and a root of higher plant (1). The ubiquity of Arbuscular Mycorrhizal Fungi (AMF) at the interface between soil and plant roots makes them a key functional group of soil biota. AMF are known to benefit plant establishment by increasing resistance to environmental stresses, enhancing plant nutrient acquisition, water relations, disease resistance and improving soil quality.(2)Vesicular-arbuscular mycorrhizal (VA) fungi colonize plant roots and ramify into the surrounding bulk soil extending the root depletion zone around the root system. They

transport water and mineral nutrients from the soil to the plant while the fungus is benefiting from the carbon compounds provided by the host plant. Therefore VA-fungi have a pervasive effect upon plant form and function (3).

Mycorrhiza is considered as fundamental parts of plant as 95% of plant species could not survive without it (4). The VAM fungal association is the most common and widely occurring in the mycorrhizal symbiosis. The mycorrhizal fungi associated with more than 80 percent of the plant species in the 90 percent of the plant families (5). Mycorrhizal fungal colonization present present in angiosperms, gymnosperms, pteridophytes and in case of some bryophytes (6). The mycorrhizal association commonly divided in to ecto-mycorrhizas and endo-mycorrhizas both are important component of soil life and soil fertility including soil chemistry. AM fungi are most important factor for rhizosphere microflora in natural ecosystem and play a main role in restoration of nutrient cycling in local ecosystem (7). The major benefit of mycorrhiza is its greater soil exploration and increasing uptake of P, N, K, Zn, Cu, S, Fe, Mg, Ca, and Mn (8). The induction of disease resistance of plant by AM fungi has become a hot spot in chemo-ecological study and biocontrol of plant diseases (9). The AM fungal colonization not only improved the growth but also enhanced the active principle content of the medicinal plants (10).

### **STUDY AREA:**

The study area is Darjeeling, West Bengal, located at Eastern Himalayan region in India. The annual mean maximum temperature is 14.9° C and annual mean minimum temperature is 8.9° C and average annual rainfall is 3092 mm (11). The altitudinal range of this hilly region varies from 150 to 3636 meter resulting in a huge contrast and diversity in climate and vegetation (12). The district is surrounded by Bhutan in the east, Nepal in the west and Sikkim of India in the north. Due to similar environmental and cultural conditions, the major inhabitants of Darjeeling hills and its surrounding areas are bonded together by Nepali language, the medium of communication among the different ethnic groups, viz. Lepchas, Bhutias, Rai, Sherpa, Tamang, Mangar, Gurung and Kagatay of the Nepali communities (13)

### **MATERIALS AND METHODS:**

#### **1. Collection of the study plants from the field**

The medicinal plants of economic kind that is *Drymaria cordata* were taken for post monsoon season from the forest areas of Darjeeling Himalaya for the study of preliminary kind. Roots of *Drymaris cordata* were collected from the rhizosphere region. The samples consisting of feeder roots were collected with the help of a soil digger (0-15cm depth) so as to represent the complex root zone. Root systems of common plant species were excavated taking care to ensure that fine roots predominate in the sample and to exclude entangled roots of other species. Sufficient samples were taken to determine if there is any variation in the constituency and degree of mycorrhizal colonization roots between or within the sampling sites.

## 2. Estimation of Root Colonization:

The root samples were cleared and processed following cold treatment. Then the samples were stained with chelpark washable royal ink and vinegar with a modified version of Philips and Hayman's method, 1970 followed by Tobo *et al.* 2011. AM fungal colonization was visualized in the root tissue of each plant species by using frequency distribution method proposed by Biermann and Lindermann, 1981. Each plant roots were divided into hundred equal segments of 1cm long and then cleared, and arranged on 20 slides so that the total length of each species was taken for study was 1 meter. The slides were observed under compound microscope to score for any structure associated with mycorrhizal fungi like hyphae, infection threads, vesicles, arbuscules in each segment. The percentage of AM fungal colonization was assessed by using the formula.  $\text{Percentage of infection} = \frac{\text{Number of root segments infected}}{\text{total number of root segments observed}} \times 100$

## RESULTS AND DISCUSSION:

From the present study it is concluded that the optimum percentage of KOH used for cold treatment in the study of arbuscular mycorrhizal fungal association in the roots of *Drymeria cordata* was in 10%, 15% and 20%, which is time dependent and need the optimum duration for the treatment which was 3 days (Table 1). The lower or higher concentration over than optimum percentages of KOH and shorter or longer duration of treatment does not give good results for the study of arbuscules, vesicles, and infection threads. Lower percentage and shorter duration does not lead to proper clearing of the roots and higher percentages of KOH

used for longer duration not only disrupts the cell structure but also have the mycorrhizal structures like arbuscules and vesicles that are unreadable.

**Table: 1**

**Effect of various percentages of KOH on the root specimens and treatment tenure required for the visibility and accountability of AM structure and host cell structure**

KOH percentage	No of days for treatment	Visibility of AM structure	Visibility of host cell structure
10	3 days	++	++
15	3 days	+++	+++
20	3 days	+++	+++
25	3 days	---	---
30	Days	---	---
10	4 days	-	-
15	4 days	++	++
20	4 days	+	+
25	4 days	---	---
30	4 days	---	---
10	5 days	---	---
15	5days	---	---
20	5 days	---	---
25	5 days	---	---
30	5 days	---	---
10	6 days	---	---
15	6 days	---	---
20	6 days	---	---
25	6 days	---	---
30	6 days	---	---

10	7 days	---	---
15	7 days	---	---
20	7 days	---	---
25	7 days	---	---
30	7 days	---	---

## CONCLUSION:

In the present study it can be concluded that the visibility of Arbuscular mycorrhizal fungal association in the roots of *Drymeria cordata* and the visibility of host cell structure can be best observed with 15 to 20% of KOH and the optimum duration for cold treatment is 3days for easy study. Further study may be made to conclude the idea in case of other species in Darjeeling Himalya.

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## **An Overview on Duodenitis and Gastric Cancer**

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### **ABSTRACT:**

The disease duodenitis is caused by *Helicobacter pylori*, a gastric pathogen, that colonizes approximately 50% of the world's population. Infection with *H. pylori* causes chronic inflammation and significantly increases the risk of developing duodenal and gastric ulcer disease and gastric cancer. The author of this article is suffering from this type of disease as evidenced by his RUT Biopsy positive result performed at R. N. Tagore Hospital, Kolkata- 99. Infection with *H. pylori* is the strongest known risk factor for gastric cancer, which is the second leading cause of cancer-related deaths worldwide. Once *H. pylori* colonize the gastric environment, it persists for the lifetime of the host, suggesting that the host immune response is ineffective in clearing this bacterium. In this review, I discuss the host immune response and examine other host factors that increase the pathogenic potential of this bacterium, including host polymorphisms, alterations to the apical-junctional complex, and the effects of environmental factors. In addition to host effects and responses, *H. pylori* strains are genetically diverse. I discuss the main virulence determinants in *H. pylori* strains and the correlation between these and the diverse clinical outcomes following *H. pylori* infection. Since *H. pylori* inhibits the gastric epithelium of half of the world, it is crucial that we continue to gain understanding of host and microbial factors that increase the risk of developing more severe clinical outcomes.

**Key words:** Strain, gastric acid secretion, *H. pylori*

### **INTRODUCTION:**

*H. pylori* is a Gram-negative bacterial pathogen that selectively colonizes the gastric epithelium. The bacterium is urease, catalase, and oxidase positive, is spiral shaped, and possesses 3 to 5 polar flagella that are used for motility. In addition, the majority of *H. pylori* strains express virulence factors that have evolved to affect host cell signaling pathways.

Among many unique characteristics of *H. pylori*, one of the most remarkable is its capacity to persist for decades in the harsh gastric environment due to an inability of the host to eliminate the infection. Unlike other viruses and bacteria, *H. pylori* has evolved the ability to colonize the highly acidic environment found within the stomach by metabolizing urea to ammonia via urease, which generates a neutral environment enveloping the bacterium (Weeks et. al., 2000). Indeed, evidence now supports the tenet that *H. pylori* has coexisted with humans for tens of thousands of years, with genetic studies indicating that humans have been colonized with *H. pylori* for at least 58,000 years (Linz, et. al., 2007). Approximately half of the world's population is infected with *H. pylori*, and the majority of colonized individuals develop coexisting chronic inflammation. In most persons, *H. pylori* colonization does not cause any symptoms Peek and Blaser. 2002. However, long-term carriage of *H. pylori* significantly increases the risk of developing site-specific diseases. Among infected individuals, approximately 10% develop peptic ulcer disease, 1 to 3% develop gastric adenocarcinoma, and <0.1% develop mucosa-associated lymphoid tissue (MALT) lymphoma (Peek and Crabtree, 2006). At early stages, gastric MALT lymphoma can be cured completely by eradication of *H. pylori* and therefore is considered the first clonal lesion which can be eliminated by treatment with antibiotics (Stolte, et. al., 2002).

### ***H. PYLORI* AND GASTRIC CANCER:**

The link between *H. pylori* and gastric cancer was a matter of debate for a number of years. However, several studies, including a study of 1,526 Japanese patients, have now provided clear evidence that *H. pylori* infection significantly increases gastric cancer risk (Uemura et. al., 2001). Uemura et al. (2001) also reported that gastric cancer developed in approximately 3% of *H. pylori*-infected patients, compared to none of the uninfected patients. Eradication of *H. pylori* significantly decreases the risk of gastric cancer in infected individuals without premalignant lesions. Randomized prospective studies demonstrated that eradication significantly reduced the presence of premalignant lesions, providing additional evidence that this organism has an effect on early stages of gastric carcinogenesis (Mera et. al., 2005 and Wong, et. al., 2004). In experimentally challenged Mongolian gerbils, eradication of *H. pylori* resulted in a significant attenuation of the progression toward gastric cancer (Nozaki et. al., 2002, Romero-Gallo et. al., 2008). Taken together, these studies support an unequivocal role for *H. pylori* in the development of gastric cancer and indicate that anti-*H.*



*pylori* therapy may be an effective means of gastric cancer prevention. Though *H. pylori* infection can be found in all regions of the world, rates of colonization vary considerably, with higher rates present in developing countries than in developed areas (Everhart, 2000). Most infections are thought to be acquired in childhood via the fecal-oral or oral-oral mode of transmission (Ernst and Gold, 2000 and Everhart, 2000). The variable outcomes of *H. pylori* infection likely depend on factors such as strain-specific bacterial constituents, inflammatory responses governed by host genetic diversity, or environmental influences, which ultimately influence the interactions between pathogen and host (Blaser and Berg, 2001). Almost 1 million cases of gastric cancer are diagnosed each year, establishing this disease as the fourth most common cancer worldwide. This is the second leading cause of cancer-related deaths, and approximately 700,000 people succumb each year to gastric adenocarcinoma (Blaser and Berg, 2001). In some regions of the world, gastric carcinoma is the most common malignancy, and in Japan, the incidence of gastric cancer is almost 10-fold higher than rates observed in the United States. Typically, the diagnosis of gastric cancer is delayed by a lack of early specific symptoms, and most patients are diagnosed after cancer has invaded the muscularis propria. This may be one explanation for why the 5-year survival rate for gastric cancer in the United States is less than 15% (Correa, 2004). Histologically, two distinct variants of gastric carcinoma have been identified: diffuse-type gastric cancer, which consists of individually infiltrating neoplastic cells that do not form glandular structures; and intestinal-type adenocarcinoma, which progresses through a series of well-defined histological steps and was first described in 1975 (Correa, 1992). Intestinal-type adenocarcinoma is initiated by the transition from normal mucosa to chronic superficial gastritis; this is followed by atrophic gastritis and intestinal metaplasia, finally leading to dysplasia and adenocarcinoma (Sipponen and Marshall, 2000). This form of gastric cancer affects men twice as commonly as women and occurs in men with a mean age of 50.4 years and in women with a mean age of 47.7 years (Hatakeyama, 2004). Corpus-predominant gastritis predisposes individuals toward gastric cancer, which is thought to be due in part to decreased acid secretion. In contrast, infection primarily of the gastric antrum results in increased acid production and predisposes individuals to duodenal ulcer disease, which is associated with a decreased risk of gastric cancer.

### **VACA TOXIN:**

An independent *H. pylori* locus linked with increased disease risk is *vacA*, which encodes the secreted toxin VacA. VacA was first identified as a proteinaceous cytotoxin that induced intracellular vacuolation of cultured cells. It was later purified to homogeneity from *H. pylori* broth culture supernatants and was identified as a protein of approximately 87 kDa in its denatured form. VacA suppresses T-cell responses to *H. pylori*, which may contribute to the longevity of infection. Recently, a deletion of 81 bp between the m region and the i region was identified and termed the d region; d1 strains have no deletion, while strains of the d2 type contain a 69- to 81-bp deletion. For a small number of Western strains, but not East Asian strains, *vacA* d1 type was significantly associated with neutrophil infiltration and gastric mucosal atrophy, potentially making the d region genotype another risk locus for gastric cancer and peptic ulceration in Western strains (Ogiwara et. al., 2009).

### **ACID SECRETION:**

Gastrin, acetylcholine, and histamine are major stimulants of gastric acid secretion. In the gastric corpus, gastrin acts directly on parietal cells and indirectly via histamine release from ECL cells, which in turn activates histamine-H<sub>2</sub> receptors on the parietal cell to elicit the release of acid. Acetylcholine acts directly on M3 receptors on the parietal cell and indirectly through histamine release from the ECL cell and inhibition of somatostatin release from D cells. Parietal cell stimulation elicits an extensive conformational transformation whereby the tubulovesicles of the resting parietal cell are transformed into secretory canaliculi. The H<sup>+</sup>K<sup>+</sup> ATPase is the primary gastric proton pump, and in unstimulated parietal cells, it is located in tubulovesicles in the cytoplasm. Upon stimulation, the H<sup>+</sup>K<sup>+</sup> ATPase is translocated to the apical membrane to mediate secretion of acid. *H. pylori* can inhibit or stimulate acid secretion, depending on the context of infection. Acute infection is usually associated with hypochlorhydria as a result of increased production of the proinflammatory cytokine IL-1 $\beta$  and inhibition of H<sup>+</sup>K<sup>+</sup> ATPase  $\alpha$ -subunit promoter activity. Indeed, recent work suggests that *H. felis* infection leads to a decrease in acid production via increased IL-1 $\beta$  acting at the parietal cell IL-1 $\beta$  receptor, which subsequently acts to decrease sonic hedgehog gene expression and to inhibit acid secretion. VacA also induces hypochlorhydria by proteolysis of ezrin, which disrupts apical membrane-cytoskeleton interactions in gastric parietal cells that are required to translocate the H<sup>+</sup>K<sup>+</sup> ATPase for acid secretion. *H. pylori* may also decrease

acid secretion through repression of  $H^+K^+$  ATPase  $\alpha$ -subunit gene expression by ERK1/2-mediated activation and translocation of NF- $\kappa$ B to the nucleus. Chronic *H. pylori* infection may result in hypochlorhydria or hyperchlorhydria, depending on the severity and distribution of gastritis. Most patients infected long-term develop pangastritis associated with hypochlorhydria, which may progress to gastric ulceration and/or adenocarcinoma. Conversely, antral predominant gastritis occurs in approximately 12% of chronically infected patients and is characterized by hyperchlorhydria, which may lead to duodenal ulcer disease.

### **OXIDATIVE DAMAGE:**

A potential contributing factor in the inflammation-to-carcinoma sequence is the generation of oxidative stress. Oxidative DNA damage induced by *H. pylori* infection has been well documented for gastritis tissues. While this may derive from infiltrating neutrophils, DNA damage has been demonstrated in gastric epithelial cell lines directly exposed to *H. pylori*. The generation of reactive oxygen species in the gastric epithelium may also contribute to dysfunction of these cells, and the oxidative stress response in gastric epithelial cells has been linked to the presence of the *cag* PAI (Ding et. al., 2007). As discussed below, polyamines have been implicated in the pathogenesis of *H. pylori* infection. One specific aspect of this is that oxidation of the polyamine spermine by the enzyme spermine oxidase (SMO; originally termed polyamine oxidase 1) is induced by upregulation of SMO in gastric epithelial cells, and this results in generation of  $H_2O_2$ . Various metabolites of  $H_2O_2$ , such as hydroxyl radicals ( $OH\cdot$ ), can be highly damaging to macromolecules within cells, including DNA. Inhibition or small interfering RNA (siRNA) knockdown of SMO blocks both apoptosis and DNA damage in gastric epithelial cells. In addition, *H. pylori*-activated macrophages also exhibit marked upregulation of SMO, which causes both apoptosis due to mitochondrial membrane depolarization and release of  $H_2O_2$  into the extracellular space, which can contribute to oxidative stress in adjacent epithelial cells.

### **ROLE OF THE HOST IMMUNE RESPONSE IN *H. PYLORI*-INDUCED CARCINOGENESIS:**

In considering the importance of host immune/inflammatory responses in the pathogenesis of *H. pylori*-induced gastric cancer, it is essential to evaluate the potential mechanisms for how immune dysregulation contributes to neoplastic transformation. In many diseases, including those resulting from chronic infections, dysregulation of the immune system is a central

component. A signature feature of *H. pylori* infection is the presence of chronic active gastritis, characterized by both chronic (lymphocytic) and active (neutrophilic) forms of inflammation. In the majority of cases, the bacterium remains in the stomach for the life of the host, indicating that the immune response is ineffective. Furthermore, the presence of inflammation for decades supports the notion that the immune response is indeed dysregulated.

## CONCLUSIONS:

Gastric cancer is a highly lethal disease, and establishment of *H. pylori* as a risk factor for this malignancy permits an approach to identify persons at increased risk; however, infection with this organism is extremely common, and most colonized persons never develop cancer. Thus, techniques to identify high-risk subpopulations must utilize other biological markers. It is apparent from recent studies that cancer risk is the summation of the polymorphic nature of the bacterial population in the host, the host genotype, and environmental exposures, each affecting the level of long-term interactions between *H. pylori* and humans. Analytical tools now exist, however, including genome sequences (*H. pylori* and human), measurable phenotypes (CagA phosphorylation), and practical animal models, and may be used to discern the fundamental biological basis of *H. pylori*-associated neoplasia, which should have direct clinical applications. For example, persons with polymorphisms associated with high levels of IL-1 $\beta$  expression and who are colonized by *cag*<sup>+</sup> strains may be most likely to derive benefit from *H. pylori* eradication, as such treatment could result in a substantially reduced cancer risk. It is important to gain more insight into the pathogenesis of *H. pylori*-induced gastric adenocarcinoma, not only to develop more effective treatments for this common cancer but also because it might serve as a paradigm for the role of chronic inflammation in the genesis of other malignancies that arise within the gastrointestinal tract.

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**Studies on the Feeding Behaviour of Red Panda (*Ailurus fulgens*) In  
Captive Condition at the Padmaja Naidu Himalayan Zoological Park,  
Darjeeling, India**

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**ABSTRACT:**

Red panda, *Ailurus fulgens* is a very cute animal, belonging to order carnivora under class mammalia. But now a days its feeding habit is totally different from a typical carnivore animal. We studied red panda under captive condition at Padmaja Naidu Himalayan Zoological Park during last one year and found many interesting observations. We also search how a carnivore can be converted into an herbivore, as well as an omnivore. Our investigation also includes the lifestyle of red panda under captive condition with a literal comparison with its wild type. There are many conflicting issues between the feeding behaviour of red panda at wild and under captivity. But one fact is here at Padmaja Naidu Himalayan Zoological Park, Darjeeling the red panda enjoys a healthy atmosphere.

**Key words:** *Ailurus fulgens*, Feeding behaviour, PNHZP, Captivity, Molar cusps.

**1. INTRODUCTION:**

Among the internet users probably there is no person in this world who doesn't know what "Mozilla Firefox" is? The answer is very simple, that, it is a "Search Engine" used for surfing internet [Mozilla, 2012]. But if the same question is asked with another aspect that what is "Firefox", then there might be only few persons who can answer it! The "fire fox" is one of another common name of Red Panda, scientifically known as *Ailurus fulgens fulgens* and it is

belonging to Order Carnivora under Class Mammalia (Fig.: 1 & 2). There are several others common names of this cute creature also. The red panda is also called lesser panda, red bear-cat and red cat-bear, is a small arboreal mammal native to the eastern Himalayas and south-western China that has been classified as *vulnerable* by IUCN as its wild population is estimated at less than 10,000 mature individuals. The population continues to decline and is threatened by habitat loss and fragmentation, poaching, and inbreeding depression, although red pandas are protected by national laws in their range countries [Wang *et. al.*,2008 and Glatston, 2010a]. The red panda is slightly larger than a domestic cat. It has reddish-brown fur, a long, shaggy tail, and a waddling gait due to its shorter front legs. It feeds mainly on bamboo, but is omnivorous and also eats eggs, birds, insects, and small mammals. It is a solitary animal, mainly active from dusk to dawn, and is largely sedentary during the day.

The red panda is the only living species of the genus *Ailurus* and the family Ailuridae. It has been previously placed in the raccoon and bear families, but results of phylogenetic research indicate strong support for its taxonomic classification in its own family Ailuridae, which along with the weasel, raccoon and skunk families is part of the superfamily Musteloidea [Flynn *et.al.*, 2000]. Two subspecies are recognized [Wozencraft, 2005]. According to evolutionary point of view it is not closely related to the giant panda.



**Fig. 1:** The Red Panda, *Ailurus fulgens fulgens*



**Fig. 2:** The logo of Mozilla Firefox.

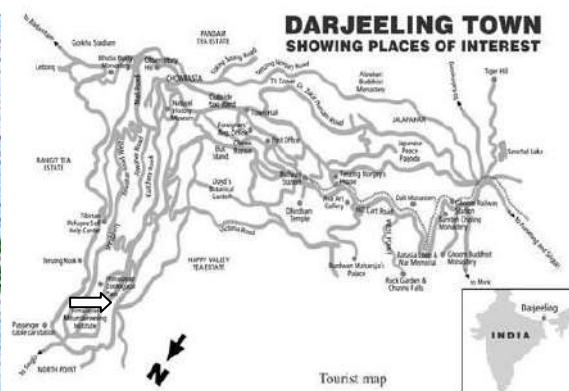
### **1.1: STUDY AREA:**

For purpose of studying red panda under captive condition the author visited Padmaja Naidu Himalayan Zoological Park of Darjeeling town (Fig.: 6, 7& 8)





**Fig. 3:** Showing the distribution of red panda.



**Fig. 4:** Location of the study area.

and is under Darjeeling district of West Bengal, India. Darjeeling (Lat.  $27^{\circ} 13' N$ ; Long.  $88^{\circ} 27' E$ ), the famous 'Queen of the Hill' town is situated at the northern part of West Bengal state and at the foothills of Himalayas.

The main objective of the present project work is to study the feeding behaviour of red panda under captive condition.

## 1.2: GEOGRAPHICAL DISTRIBUTION:

The red panda is endemic to the temperate forests of the Himalayas, and ranges from the foothills of western Nepal to China in the east [Glatston, 1994]. Its easternmost limit is the Qinling Mountains of the Shaanxi Province in China. Its range includes southern Tibet, Sikkim and Assam in India, Bhutan, the northern mountains of Burma, and in south-western China, in the Hengduan Mountains of Sichuan and the Gongshan Mountains in Yunnan. It may also live in south-west Tibet and northern Arunachal Pradesh, but this has not been documented. Locations with the highest density of red pandas include an area in the Himalayas that has been proposed as having been a refuge for a variety of endemic species in the Pleistocene. The distribution range of the red panda should be considered disjunct, rather than continuous [Roberts and Gittleman, 1984]. A disjunct population inhabits the Meghalaya Plateau of north-eastern India [Chudhury, 2001].

During a survey in the 1970s, signs of red pandas were found in Nepal's Dhorpatan Hunting Reserve [Wegge, 1976]. Their presence was confirmed in spring 2007 when four red pandas were sighted at elevations ranging from 3,220 to 3,610 m (10,560 to 11,840 ft) [Sharma and Belant, 2009]. The species' westernmost limit is in Rara National Park located farther west of the Dhorpatan Hunting Reserve [Bolton, 1976]. Their presence was confirmed in 2008 [Sharma, 2008].

The red panda lives between 2,200 and 4,800 meters (7,200 and 15,700 ft) altitude, inhabiting areas of moderate temperature between 10 and 25 °C (50 and 77 °F) with little annual change. It prefers mountainous mixed deciduous and conifer forests, especially with old trees and dense understories of bamboo [Roberts and Gittleman, 1984 and Glatston, 1994].

The red panda population in Sichuan Province is larger and more stable than the Yunnan population, suggesting a southward expansion from Sichuan into Yunnan in the Holocene [Bing *et. al.*, 2001].

The red panda has become extirpated from the Chinese provinces of Guizhou, Gansu, Shaanxi and Qinghai [Wei *et. al.*, 1999a].

3.2.1 Distribution of the red panda is disjointed, with two extant subspecies:

- Western red panda *A. f. fulgens* [Cuvier, 1825] lives in the western part of its range, in Nepal, Assam, Sikkim and Bhutan
- Styan's red panda *A. f. styani* lives in the east-north-eastern part of its range, in southern China and northern Burma [Glover, 1938].

*Ailurus fulgens styani* has been described by Thomas in 1902 based on one skull from a specimen collected in Szechwan [Thomas, 1902]. Pocock distinguished *A. f. styani* from *A. f. fulgens* by its longer winter coat and more abundant blackness in the pelage, bigger skull, more strongly curved forehead, and more robust teeth. His description is based on skulls and skins collected in Szechwan, Myitkyina close to the border of Yunnan, and Upper Burma [Pocock, 1941].



**Fig. 5:** Darjeeling district map.



**Fig. 6:** Logo of PNHNP, Darjeeling.

The Styan's red panda is supposedly larger and darker in color than the Western member of the species, but with considerable variation in both subspecies, and some individuals may be brown or yellowish brown rather than red [Glatston, 1994].

The Brahmaputra River is often considered the natural division between the two subspecies, where it makes a curve around the eastern end of the Himalayas, although some authors suggest *A. f. fulgens* extends farther eastward, into China.



**Fig. 7:** Entrance of PNHZP, Darjeeling. **Fig. 8:** Route map of PNHZP, Darjeeling.

(PNHZP = Padmaja Naidu Himalayan Zoological Park, Darjeeling)

### 1.3: VERNACULAR NAMES:

The red panda's local names differ from place to place. The Lepcha people call it *sak nam*. In Nepal, the species is called *bhalu biralo* (bear-cat) and *habre*. The Sherpa people of Nepal and Sikkim call it *ye niglva ponva* and *wah donka* [Shrestha, 2003]. The word *wā:* is Sunuwari meaning bear; in Tamang language, a small, red bear is called *tāwām* [Hale, 1973]. In the Kanchenjunga region of eastern Nepal, the Limbus know red pandas as *kaala*, which literally means dark because of their underside pelage; villagers of Tibetan origin call them *hoptongar* [Yonzon, 1996].

Additionally, Pocock lists the vernacular names *ye* and *nigálya ponya* (Nepal); *thokya* and *thongwa* (Limbu); *oakdonga* or *wakdonka* and *woker* (Bhotia); *sak nam sunam* (Lepcha) [Pocock, 1941]. *Nigálya* may originate from the Nepali word *निङालो* *niñālo* or *nīgālo* meaning a particular kind of small bamboo, namely *Arundinaria intermedia*, but also refers to a kind of small leopard, or cat-bear [Turner, 2010a]. The word *pónya* may originate from the Nepali word *पञ्जा* *pajā* meaning claw, or *पौजा* *paūjā* meaning paw of an animal [Turner, 2010b]. *Nigálya pónya* may translate to bamboo claw or paw.

*Nigálya pónya*, *nyala ponga* [Heuvelmans, 1958], and *poonya* [Glatston, 2010b] are said to mean eater of bamboo. The name panda could originate from *panjā* [Catton, 1990].

In modern Chinese, the red panda is called *xiǎoxióngmāo* (小熊猫, lesser or small panda) [MDBG, 2011a], or 红熊猫/紅熊猫 (*hóngxióngmāo*, red panda) [MDBG, 2011b]. In contrast, the giant panda is called *dàxióngmāo* (大熊猫/大熊貓, giant or big panda), or simply *xióngmāo* (熊猫/熊貓, panda, literally bear-cat).

In English, the red panda is also called lesser panda, though "red" is generally preferred. Many other languages use red panda, or variations of shining/gold or lesser/small in their names for this species. For instance, червена панда in Bulgarian, *panda roux* in French, and *panda rojo* in Spanish all mean red panda. Since at least as far back as 1855, one of its French names has been *panda éclatant* (shining panda) [Gervais, 1855]. In Finnish, it is called *kultapanda* (gold panda). Variations of lesser panda occur in French *petit panda* (small panda), in Spanish *panda menor* (lesser panda), in Dutch *kleine panda* (small panda), in Russian «малая панда» (*malaya panda*, "small panda"), in Korean 애기판다 (*aeki panda*, "baby panda"), in Japanese ressā panda (レッサーパンダ *transliteration of English "lesser panda"*<sup>2</sup>).

Other names attributed to this species include fire cat, fire fox, bright panda and common panda [Roberts, 1992].

Therefore, from the above discussion it is appear that this beautiful creature, red panda is absolutely a threatened animal throughout the globe; therefore, under university as well as departmental curriculum of our fourth semester syllabus this interesting aspect is taken as project work to study the feeding behaviour of red panda as possible in details under captive condition.

## 2. MATERIALS AND METHODS:

The present study has been undertaken only for observation under captive condition. Therefore, for this purpose the author visited the Padmaja Naidu Himalayan Zoological Park of Darjeeling town twice a week (Fig. 5, 6, 7 & 8). Darjeeling (Lat. 27° 13' N; Long. 88° 27' E), the famous 'Queen of the Hill' town is situated at the northern part of West Bengal, India. The total tenure of this project work is one year, i.e., from July 2014 to June 2015. Every kind of behaviour shown by the red pandas has been noted carefully and chronologically. In every possible case photography has been done by the aid of digital still camera (Canon 60 E). Under captive condition it was not possible to study each and every



event; therefore, help of zoo authorities were taken regarding obtaining various data and information. Other data and information were collected from different books, journals and also from internet data base.

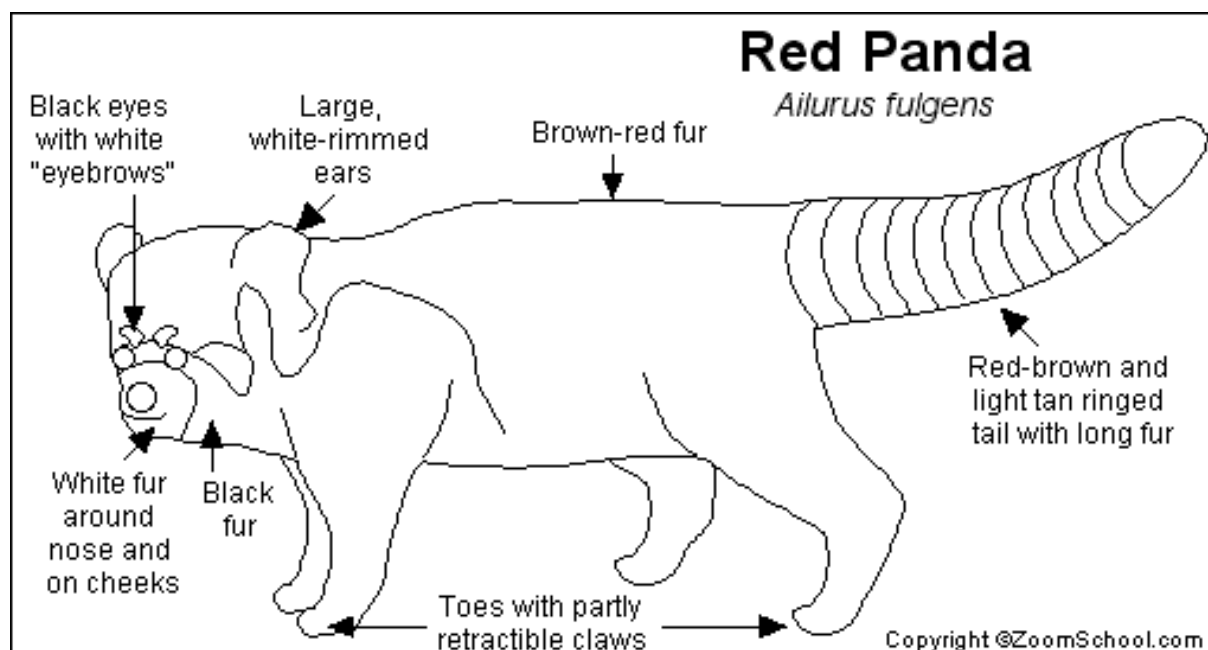


**Fig. 9, 10 & 11:** Red Panda – Adult (at both side) and Juvenile (in the middle).

### 3. RESULTS AND OBSERVATIONS:

#### 3.1: MORPHOLOGICAL FEATURES:

The head and body length of red pandas measures 50 to 64 cm (20 to 25 in), and their tail is 28 to 59 cm (11 to 23 in). Males weigh 3.7 to 6.2 kg (8.2 to 13.7 lb) and females 3 to 6.0 kg (6.6 to 13.2 lb) [Roberts and Gittleman, 1984; IT IS, 2009; and Burnie and Wilson, 2005]. They have long, soft reddish-brown fur on the upper parts, blackish fur on the lower parts, and a light face with tear markings and robust cranial-dental features. The light face has white badges similar to those of a raccoon, but each individual can have distinctive markings.



**Fig.12:** Body colour pattern of red panda.

Their roundish head has medium-sized upright ears, a black nose, and very dark eyes: almost pitch black. Their long bushy tail with six alternating yellowish red transverse ochre rings provides balance and excellent camouflage against its habitat of moss- and lichen-covered trees. The legs are black and short with thick fur on the soles of the paws. This fur serves as thermal insulation on snow-covered or ice surfaces and conceals scent glands which are also present on the anus [Pocock, 1941](Fig.: 1, 9, 10, 11 & 12).

The red panda is specialized as a bamboo feeder with strong, curved and sharp semi-retractile claws [Roberts and Gittleman, 1984] standing inward for grasping of narrow tree branches, leaves and fruit. Like the giant panda, it has a “false thumb” that is an extension of the wrist bone. When descending a tree head-first, the red panda rotates its ankle to control its descent, one of the few climbing species to do so [Fisher *et. al.*, 2008].

### **3.2: HABITAT:**

The red panda is territorial; it is solitary except during mating season. The species is generally quiet except for some twittering, tweeting, and whistling communication sounds. It has been reported to be both nocturnal and crepuscular, sleeping on tree branches or in tree hollows during the day and increasing its activity in the late afternoon and early evening hours. It sleeps stretched out on a branch with legs dangling when it is hot, and curled up with its tail over the face when it is cold [Roberts and Gittleman, 1984]. This panda is very heat sensitive, with an optimal “well-being” temperature between 17 and 25 °C (63 and 77 °F), and cannot tolerate temperatures over 25 °C (77 °F).

Shortly after waking, red pandas clean their fur like a cat, licking their front paws and then rubbing their backs, stomachs and sides. They also rub their backs and bellies along the sides of trees or rocks. Then they patrol their territories, marking with urine and a weak musk-smelling secretion from their anal glands. They search for food running along the ground or through the trees. Red pandas may alternately use their forepaws to bring food to their mouths or place food directly into their mouths [Roberts and Gittleman, 1984].

Predators of the red panda include the snow leopard, martens (Mustelidae), and humans. If they feel threatened or sense danger, they may try to escape by climbing a rock column or tree. If they can no longer flee, they stand on their hind legs to make themselves appear larger and use the sharp claws on their front paws to defend themselves. The red panda Futa became a visitor attraction in Japan for his ability to stand upright for ten seconds at a time (Fig.: 11 & 31).

### 3.3: FEEDING BEHAVIOUR:

By studying red panda under captive condition many types of behaviour related to feeding habit has been observed of which some interesting ones are mentioned here. Red pandas are excellent climbers, and forage largely in trees. They eat mostly bamboo, and may eat small mammals, birds, eggs, flowers and berries. In captivity, they were observed to eat birds, flowers, maple and mulberry leaves, and bark and fruits of maple, beech and mulberry [Roberts and Gittleman, 1984]. Like the giant panda, they cannot digest cellulose, so they must consume a large volume of bamboo to survive. Their diets consist of about two-thirds bamboo, but they also eat mushrooms, roots, acorns, lichen and grasses. Occasionally, they supplement their diets with fish and insects. They do little more than eat and sleep due to their low-calorie diets.

Bamboo shoots are more easily digested than leaves, exhibiting the highest digestibility in summer and autumn, intermediate digestibility in the spring, and lowest digestibility in the winter. These variations correlate with the nutrient contents in the bamboo. Red pandas process bamboo poorly, especially the cellulose and cell wall components. This implies microbial



**Fig. 13 & 14:** Feeding of newborn red panda (at left) and juvenile (at right) by using feeding bottle [Under captive condition].

digestion plays only a minor role in their digestive strategy. To survive on this poor-quality diet, they have to eat the high-quality sections of the bamboo plant, such as the tender leaves and shoots, in large quantities, over 1.5 kg (3.3 lb) of fresh leaves and 4 kg (8.8 lb) of fresh shoots daily. This food passes through the digestive tract fairly rapidly (about 2–4 hr) so as to maximize nutrient intake [Wei et. al., 1999b]. Red pandas can taste artificial sweeteners, such as aspartame, the only non-primate known to do so [BBC News, 2008](Fig. 15).

At the Padmaja Naidu Himalayan Zoological Park, Darjeeling there are specific recommended diet for red pandas (Fig.: 15), which includes raw egg, banana, milk (Amul brand), apple, ripe

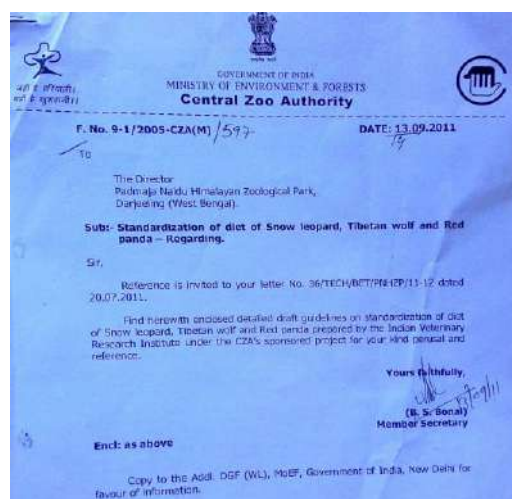


REVISED FEEDING CHART OF ALL ANIMALS AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK (2013)			
Beat No 1			
Pheasants (34:38) (72 nos)	Feed Items	Quantity per individual	
Red Panda (4:0)	Egg (Raw)	1 pc ✓	
	Banana	2 pcs ✓	
	Apple	300 gms ✓	
	Papaya (ripe)	200 gms ✓	
	Honey	50 ml ✓	
	Sugar (if honey not available)	20 gms ✓	
	Milk (Amul)	300ml ✓	
	Fresh Bamboo leaves	4 kg ✓	
	Molasses Chappati	2 pcs	
	Sweet Bun		

**Fig. 15:** Feeding chart of red panda (edited form) at PNHZP, Darjeeling.

papaya, honey / sugar, bamboo leaves, sweet bun in a particular quantity as shown in the Figure 15. Red panda is an animal under order Carnivora of class Mammalia. The main diet of carnivore animals are flesh, however, in course of evolution the red pandas are adapted to an omnivore feeding habit. Under captive condition the red pandas are also adapted to enjoy human care even during their infancy (Fig.: 13 & 14).

The feeding standard of red panda as well as other animals at the Padmaja Naidu Himalayan Zoological Park, Darjeeling is prepared by the Indian Veterinary Research Institute (Fig.:16). And the zoo authority maintains these feeding standard very strictly. If any visitor is seen to trying supply any food matter then zoo authority takes their necessary step.



**Fig.16:** Feeding recommendation

**Fig.17:** Red panda taking bamboo leaves as their food.

in favour of red panda.



Chemical composition of food of red panda is also varies in different zoos (Fig.:18) and there are different recommended chemical composition of food in different zoos (Fig. 18). The food consumption, food digestibility and nutritional adequacy parameters are also vary in different zoos. At Figure 19 such some comparative parameters are shown which are applicable for the zoos of Darjeeling and Gangtok (State Capital of Sikkim, India).

Table 1. Chemical Composition of Diet Fed to red panda in Different Zoos

	On DM basis								
	Dry matter%	GE (Kcal/kg DM)	CP%	NDF%	Cell%	P%	Ks ppm	Ca ppm	Cu ppm
<b>Darjeeling</b>									
Sweet from Banana	58.22	4240	12.34	9.4	0.27	0.41	67	21	9
Banana	24.11	4100	5.37	11.8	0.11	0.15	23	27	9
Apple	15.23	3480	6.01	8.1	0.1	0.08	33	24	7
milk	12.28	5480	26.4	0	1.04	0.98	4	35	5
sugar		4000	0	0					
Bamboo offered	51.31	4080	7.2	74.87	0.74	0.32	182	29	12
Bamboo residue	60.72	3880	5.5	78.15	0.64	0.21	152	21	9
<b>Gangtok</b>									
Bread	55.97	4200	11.94	10.2	0.31	0.39	64	23	8
Banana	23.77	4040	5.62	12.3	0.09	0.22	21	22	9
Apple	15.14	3510	5.42	16.9	0.12	0.09	35	23	9
papaya	10.74	3810	5.92	14.4	0.27	0.08	0	33	12
canal	8.94	4040	11.24	24.7	0.33	0.36	64	32	10
milk	12.78	5440	26.2	0	1.14	0.86	5	37	5
bamboo offered	51.31	4052	8.3	74.64	0.81	0.41	185	35	13
Bamboo residue	60.72	3890	5.9	79.1	0.66	0.35	161	28	11

CP, crude protein; DM, dry matter; GE, gross energy; NDF, neutral detergent fibre; ppm, parts per million

Table 2. Food consumption, diet digestibility and nutritional adequacy of red panda diet in different zoos

Parameters	Darjeeling	Gangtok
Dry matter intake (g/day)		
From non-bamboo food	165.3±7.9	119±12.2
From bamboo	234.7±12.3	266.2±27.7
Total	400±16.1	385.6±39.9
Dry matter digestibility (%)	36.08±0.22	45.32±0.99
Digestible energy intake (Kcal/kg W <sup>0.75</sup> )	259.1±10.8	222.8±10.1
<b>Diet adequacy</b>		
NDF content (%)	37.91±1.67	41.1±2.76
Crude protein content (%)	13.68±0.52	16.47±1.18
Ca (%)	0.83±0.03	1.12±0.07
P (%)	0.62±0.03	0.57±0.03
Fe ppm	205.0±9.36	213±12.9
Zn ppm	49.7±2.40	54.2±3.7
Cu ppm	18.6±0.92	17.9±1.12

**Fig. 18:** Chemical composition of food. **Fig. 19:** Food consumption, food digestibility and nutritional adequacy parameter table of red panda at zoos.

The adult red pandas enjoy many types of food as shown in the Figures 20, 21, 22, 23, 24 and 25.



**Fig. 20& 21:** Red panda taking fruits as food (even from human hand).



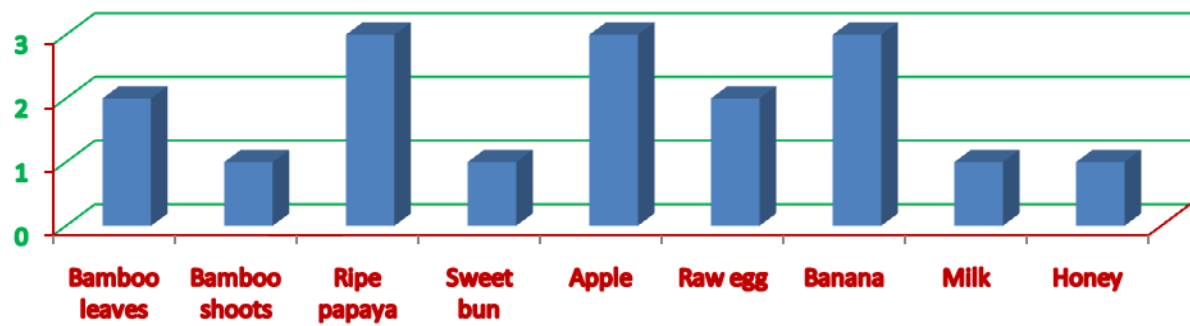
**Fig. 22 & 23:** Pumpkin and sugarcane shoot also form diet for red panda.



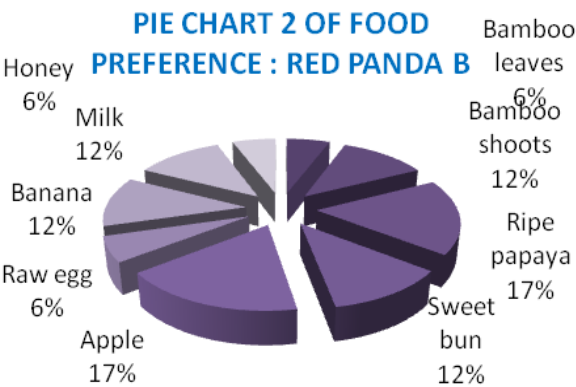
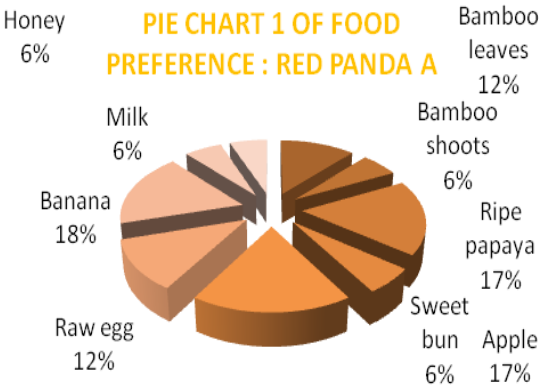
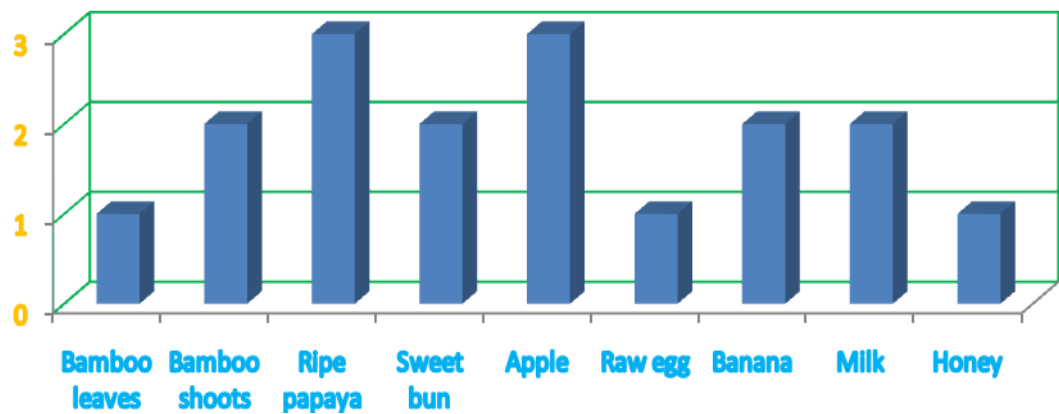
**Fig. 24 & 25:** Bamboo leaves and shoots are the main food of red panda; even they enjoy their “birthday gift” as different food item also with pleasure (right).

With reference to the choice of food some observations have been made during studies under captive condition. If different types of food are available / supplied simultaneously the red panda

COLUMN CHART 1 : RED PANDA A



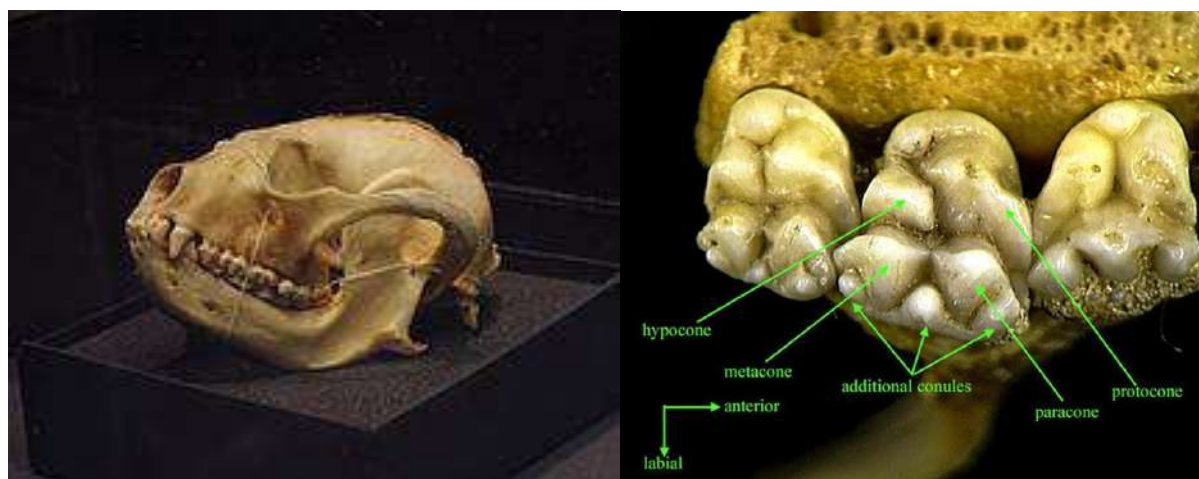
COLUMN CHART 2 : RED PANDA B





prefers fruits as their choice as it was observed at Padmaja Naidu Himalayan Zoological Park, Darjeeling. There are two red panda at PNHZP, Darjeeling which are here designated as Red Panda A & B. By comparing the above two column charts, 1 and 2 of food preference striking similarities have been found between the food preferences of two Red Panda A & B. In both the cases the pandas preferred ripe papaya (17%) and apple (17%)[Banana 18% in case of A]; whereas, others available foods are preferred secondarily, however, bamboo leaves is the main diet of red panda. The same type of observations can be seen at the Pie charts, 1 and 2 of food preference of red pandas A and B also.

Red panda is a carnivorous animal but its feeding habit is somewhat not like a typical carnivore. Red Pandas belong to a subfamily within the Ailuridae known as the Ailurinae. Members of this group display a general trend toward hypocarnivory (an animal whose diet consists of less than 30% animal matter) which is reflected by the broadening of their carnassials (specialized shearing cheek teeth found in terrestrial mammalian predators) and posterior premolars with the addition of grinding cusps. These changes were particularly evident in the ancestral *Parailurus* and further emphasized in the modern species. As mentioned above, the Red Panda specializes in eating bamboo. Bamboo is an extremely tough plant with a low



**Fig. 26:** Structure of skull of Red Panda.    **Fig. 27:** Molar cusps of red panda.

[Both the photographs are obtained from internet source]

nutritional value, and so the Red Panda has had to undergo several cranial and dental modifications to get the most out of this poor diet. The skull has become broader and more

domed compared to other ailurines with a pronounced sagittal crest (Fig.: 26, 27 & 28). The premolars have become fully molariform (the condition in which non-molar teeth take on the form and function of true molars) to expand the grinding surface. Figure 27 showing that upper dentition (P4, M1, & M2) of the extant Red Panda (*Ailurus fulgens*). Note the extreme molarization of P4 (upper carnassial) and the additional grinding cusps adapted to crush bamboo [Glatston, 2007a and Glatston, 2007b]. The carnassials have completely lost their shearing function, are much wider than they are long, and have developed multiple enlarged cusps. Endowed with an immensely powerful bite for its size and efficient grinding teeth, Red Pandas are able to consume large quantities of bamboo per day (Fig.: 28, 29 & 31).



**Fig. 28:** Ailurinae skull of red panda.

**Fig. 29:** Food web of red panda.

It is unclear when the genus *Ailurus* originated, but it may have descended from the extinct genus *Parailurus* in central Asia sometime during the Pliocene. Other members of Ailuridae became extinct, possibly due to the drastic changes in habitat and climate that occurred toward the end of the Pliocene and continued throughout the Pleistocene. The Red Panda has persisted because it is a specialist, adapted to the temperate high-altitude forests of the Himalayas where it feeds almost exclusively on bamboo [Glatston, 2010b].

Predators of the red panda include the snow leopard, martens (*Mustelidae*), and humans. If they feel threatened or sense danger, they may try to escape by climbing a rock column or tree [Glatston, 2010b]. If they can no longer flee, they stand on their hind legs to make themselves appear larger and use the sharp claws on their front paws to defend themselves. Figure 29 showing food web of red panda.

The Red Panda is highly arboreal and demonstrates a number of anatomical characteristics that make it highly adept at climbing trees. The tail is long and used as a counterbalancing aid. Broad paws with recurved semi-retractable claws provide a powerful grip and rough paw

pads enhance traction. The body is nimble with powerful muscles in the forelimbs and lower back which they use to swiftly propel themselves up vertical surfaces. Another valuable climbing tool is the radial sesamoid bone or “false thumb”. This modified wrist bone is mobile and able to oppose the first digits of the forepaw, creating an effective pincer-action ideal for clamping on to tree trunks and thin branches. This adaptation can also be used to grip and manipulate food items [Glatston, 1994b] (Fig.: 30).



**Fig. 30:** Red panda “A & B” are playing. **Fig. 31:** The upright posture of red panda.

Diet of wild animals in captive condition, is very crucial. There is very few knowledge regarding the feeding habit of red panda in the wild. Whatever information is available, 90% of food of red panda is constituted by bamboo. Beside bamboo it also takes fruits, insects and small mammals as food [Glatston, 1994b].

The anatomical feature of digestive system of red panda is also an exception. Red panda takes a lot of vegetable items as food but they have no ruminant – like stomach and have no caecum for cellulose digestion. The length of intestine is alike civet or racoon. Microorganisms are also not present in their gut for aid to bamboo digestion [Glatston, 2007a and Glatston, 2007b].

The dentition pattern of red panda is typically carnivore type with an exception, i.e., the 4<sup>th</sup> upper premolar is missing (Fig.: 27), however, the teeth is more alike ruminants than carnivore. All the cheek teeth are unusually large, flat and broad with a complex pattern of ridges [Glatston, 2007a and Glatston, 2007b].

The skull is massive and heavily boned, the deep skull and prominent cheek bones provide anchor points for powerful muscles that close the jaws. This is the reason why the red panda tries to feed other local grasses or leaves of trees in the absence of bamboo.

In the Padmaja Naidu Himalayan Zoological Park, Darjeeling the red pandas are provided food for two times a day. Previously they were provided sugar [Glatston, 2010b] but now a days, after 2013 honey is given to the red pandas to avoid dental problem (Fig.: 15) and if honey is unavailable then only sugar is provided. However, no report is available from Darjeeling related to dental problem of red panda.

### **3.4: THREATS:**

The primary threats to red pandas are direct harvest from the wild, live or dead, competition with domestic livestock resulting in habitat degradation, and deforestation resulting in habitat loss or fragmentation. The relative importance of these factors is different in each region, and is not well understood [Glatston, 1994]. For instance, in India, the biggest threat seems to be habitat loss followed by poaching, while in China, the biggest threat seems to be hunting and poaching [Wang *et. al.*, 2008]. A 40% decrease in red panda populations has been reported in China over the last 50 years, and populations in western Himalayan areas are considered to be lower [18Wei *et. al.*, 1999a].

Deforestation can inhibit the spread of red pandas and exacerbate the natural population subdivision by topography and ecology, leading to severe fragmentation of the remaining wild population. Fewer than 40 animals in four separate groups share resources with humans in Nepal's Langtang National Park, where only 6% of 1,710 square kilometres (660 sq mi) is preferred red panda habitat. Although direct competition for food with domestic livestock is not significant, livestock can depress bamboo growth by trampling [Yonzon *et. al.*, 1991].

Small groups of animals with little opportunity for exchange between them face the risk of inbreeding, decreased genetic diversity, and even extinction. In addition, clear-cutting for firewood or agriculture, including hillside terracing, removes old trees that provide maternal dens and decreases the ability of some species of bamboo to regenerate [Glatston, 1994].

In south-west China, red pandas are hunted for their fur, especially for the highly valued bushy tails from which hats are produced. In these areas, the fur is often used for local cultural ceremonies. In weddings, the bridegroom traditionally carries the hide. The "good-luck charm" red panda-tail hats are also used by local newly-weds [Wei *et. al.*, 1999a]. This

practice may be quite old, as the red panda seems to be depicted in a 13th-century Chinese pen-and-ink scroll showing a hunting scene. Little or no mention of the red panda is made in the culture and folklore of Nepal [IUCN, 1994].

In the past, red pandas were captured and sold to zoos. Angela Glatston reported she had personally handled 350 red pandas in 17 years [Glatston, 1994a].

Thanks to CITES, this number has decreased substantially in recent years, but poaching continues, and red pandas are often sold to private collectors at exorbitant prices. In some parts of Nepal and India, red pandas are kept as pets [WWF, 2009].

The red panda has a naturally low birth rate (usually single or twin births per year), and a high death rate in the wild.

### **3.5: CONSERVATION STATUS:**

The red panda is listed in CITES Appendix I [CITES, 2010]. The species has been classified as vulnerable in the IUCN Red List since 2008 because the global population is estimated at about 10,000 individuals, with a decreasing population trend; only about half of the total area of potential habitat of 142,000 km<sup>2</sup> (55,000 sq mi) is actually being used by the species. Due to their shy and secretive nature, and their largely nocturnal habits, observation of red pandas is difficult. Therefore, population figures in the wild are determined by population density estimates and not direct counts [Wang *et. al.*, 2008].

Worldwide population estimates range from fewer than 2,500 individuals [Nowak, 1999] to between 16,000 and 20,000 individuals [Choudhury, 2001]. In 1999, the total population in China was estimated at between 3,000 and 7,000 individuals [Wei *et. al.*, 1999a]. In 2001, the wild population in India was estimated at between 5,000 and 6,000 individuals [Choudhury, 2001]. Estimates for Nepal indicate only a few hundred individuals [Massicot, 2006]. There are no records from Bhutan or Burma.

Reliable population numbers are hard to find, partly because other animals have been mistaken for the red panda. For instance, one report from Burma stated that red pandas were still fairly common in some areas, and was accompanied by a photograph of a "red panda" as proof. The photograph in question depicted a species of civet [Glatston, 1994b].

The red panda is protected in all range countries, and hunting is illegal [Wang *et. al.*, 2008]. Beyond this, conservation efforts are highly variable between countries:



- China has 35 protected areas covering about 42.4% of red panda habitat [Wang *et. al.*, 2008].
- India has 20 protected areas with known or possible red panda populations in Sikkim, Arunachal Pradesh and West Bengal such as Khangchendzonga National Park, Namdapha National Park and Singalila National Park, and a coordinated conservation policy for the red panda [Wang *et. al.*, 2008].
- In Nepal, known populations occur in Langtang National Park, Sagarmatha National Park, Makalu Barun National Park, Rara National Park, Annapurna Conservation Area, Kanchenjunga Conservation Area, and in Dhorpatan Hunting Reserve [Bhujju *et. al.*, 2007].
- Bhutan has five protected areas that support red panda populations [Wang *et. al.*, 2008].
- Burma has 26 protected areas, of which at least one hosts red panda populations [Wang *et. al.*, 2008].

### **3.5.1: *in situ* STATUS:**

A community-managed forest in Ilam District of eastern Nepal is home to 15 red pandas which generate household income through tourism activities, including home stays. Villagers in the high-altitude areas of Arunachal Pradesh have formed the Pangchen Red Panda Conservation Alliance comprising five villages with a community-conserved forest area of 200 km<sup>2</sup> (77 sq mi) at an altitude of 2,500 m (8,200 ft) to over 4,000 m (13,000 ft) [Ghimire and Bhatta, 2010].

### **3.5.2: *ex situ* STATUS (UNDER CAPTIVE CONDITION):**

The red panda is quite adaptable to living in captivity, and is common in zoos worldwide. By 1992, more than 300 births had occurred in captivity, and more than 300 individuals lived in 85 institutions worldwide [Roberts, 1992]. By 2001, there were 182 individuals in North American zoos alone [Kive, 2008]. As of 2006, the international studbook listed more than 800 individuals in zoos and parks around the world. Of these, 511 individuals of subspecies *A. f. fulgens* were kept in 173 institutions [Glatston, 2007a] and 306 individuals of subspecies *A. f. styani* were kept in 81 institutions [Glatston, 2007b].

The International Studbook is currently managed at the Rotterdam Zoo in the Netherlands. In cooperation with the International Red Panda Management Group, they coordinate the Species Survival Plan in North America, the European Endangered Species

Programme in Europe and other captive-breeding programs in Australia, India, Japan and China [Glatston, 2007b and National Studbook, 2009]. In 2009, Sarah Glass, curator of red pandas and special exhibits at the Knoxville Zoo in Knoxville, Tennessee, was appointed as coordinator for the North American Red Panda Species Survival Plan. The Knoxville Zoo has the largest number of captive red panda births in the Western Hemisphere (101 as of August 2011). Only the Rotterdam Zoo in the Netherlands has had more captive births worldwide [Glatston, 2007a and Glatston, 2007b].

The Padmaja Naidu Himalayan Zoological Park in Darjeeling, India successfully released four captive-bred red pandas to the wild in August and November 2009 [National Studbook, 2009].

Three red panda cubs were born in captivity at Hamilton Zoo in New Zealand in December 2012, doubling the number held there [News NZ, 2013].

### **3.6: PHYLOGENETIC HISTORY:**

The taxonomic classification of the red panda has been controversial since it was discovered. French zoologist Frédéric Cuvier initially described the red panda in 1825, and classified it as a close relative of the raccoon (Procyonidae), though he gave it the genus name *Ailurus*, (from Ancient Greek αἴλουρος, "cat"), based on superficial similarities with domestic cats. The specific epithet is the Latin adjective *fulgens*, "shining" [Simpson, 1979]. At various times, it has been placed in Procyonidae, Ursidae, with *Ailuropoda* in Ailuropodinae (until this family was moved into Ursidae), and in its own family, Ailuridae. This uncertainty comes from difficulty in determining whether certain characteristics of *Ailurus* are phylogenetically conservative or are derived and convergent with species of similar ecological habits [Roberts and Gittleman, 1984].

Evidence based on the fossil record, serology, karyology, behavior, anatomy, and reproduction reflect closer affinities with Procyonidae than Ursidae. However, ecological and foraging specializations and distinct geographical distribution in relation to modern procyonid support classification in the separate family Ailuridae [Wozencraft, 2005; Roberts and Gittleman, 1984; and Flynn *et. al.*, 2005].

Recent molecular systematic DNA research also places the red panda into its own family, Ailuridae, which is in turn part of the broad superfamily Musteloidea that also includes the skunk, raccoon, and weasel families [Flynn *et. al.*, 2005; Flynn *et. al.*, 2000; and Flynn and Nedbal, 1998].

It is not a bear, nor closely related to the giant panda, nor a raccoon, nor a lineage of uncertain affinities. Rather it is a basal lineage of musteloid, with a long history of independence from its closest relatives (skunks, raccoons, and otters/weasels/badgers).

There are two subspecies, *A. f. fulgens* and *A. f. styani*. However, the name *Ailurus fulgens refulgens* is sometimes incorrectly used for *A. f. styani*. This stems from a lapsus made by Henri Milne-Edwards in his 1874 paper "*Recherches pour servir à l'histoire naturelle des mammifères comprenant des considérations sur la classification de ces animaux*" [Milne-Edwards, 1874], making *A. f. refulgens* a *nomen nudum* [Pocock, 1941 and Glover, 1938]. The most recent edition of *Mammal Species of the World* still shows the subspecies as *A. f. refulgens* [Wozencraft, 2005]. This has been corrected in more recent works, including *A guide to the Mammals of China* [Smith and Yan Xie, 2008] and *Handbook of the Mammals of the World, Volume 1: Carnivores* [Wilson and Mittermeier, 2009].

### 3.7: STORY OF EVOLUTION:

The red panda is considered a living fossil and only distantly related to the giant panda (*Ailuropoda melanoleuca*), as it is naturally more closely related to the other members of the superfamily Musteloidea to which it belongs. The common ancestor of both pandas (which also was an ancestor for all living bears, pinnipeds -the walrus and seals- and musteloids -raccoons, skunks, weasels, otters...) can be traced back to the Early Tertiary period tens of millions of years ago, with a wide distribution across Eurasia.

Fossils of the extinct red panda *Parailurus anglicus* have been unearthed from China in the east to Britain in the west [Naish, 2008]. In 1977, a single tooth of *Parailurus* was discovered in the Pliocene Ringold Formation of Washington. This first North American record is almost identical to European specimens and indicates the immigration of this species from Asia [Tedford, 1977]. In 2004, a tooth from a red panda species never before recorded in North America was discovered at the Gray Fossil Site in Tennessee. The tooth dates from 4.5–7 million years ago. This species, described as *Pristinailurus bristoli*, indicates that a second, more primitive ailurine lineage inhabited North America during the Miocene. Cladistic analysis suggests that *Parailurus* and *Ailurus* are sister taxa [Naish, 2008; and Wallace and Wang, 2004]. Additional fossils of *Pristinailurus bristoli* were discovered at the Gray Fossil site in 2010 and in 2012 [AOI News, 2010 and Rex, 2012]. The frequency with which panda

fossils are being found at Gray Fossil Site suggests the species played a large role in the overall ecosystem of the area.

The discovery in Spain of the postcranial remains of *Simocyon batalleri*, a Miocene relative to the red panda, supports a sister-group relationship between red pandas and bears. The discovery suggests the red panda's "false thumb" was an adaptation to arboreal locomotion — independent of the giant panda's adaptation to manipulate bamboo — one of the most dramatic cases of convergent evolution among vertebrates [Salesa *et. al.*, 2006].

### **3.8: TAXONOMIC HISTORY:**

The first known written record of the red panda occurs in a 13th-century Chinese scroll depicting a hunting scene between hunters and the red panda [IUCN, 1994 and Roberts, 1992].

Major General Thomas Hardwicke's 1821 presentation of an article titled "Description of a new Genus of the Class Mammalia, from the Himalaya Chain of Hills Between Nepaul and the Snowy Mountains" at the Linnean Society in London is usually regarded as the moment the red panda became a *bona fide* species in Western science. Hardwicke proposed the name "wha" and explained: "It is frequently discovered by its loud cry or call, resembling the word 'Wha', often repeating the same: hence is derived one of the local names by which it is known. It is also called *Chitwa*." Hardwicke's paper was not published until 1827, by which time Frédéric Cuvier had published his description and a figure. Hardwicke's originally proposed taxonomic name was removed from the 1827 publication of his paper with his permission, and naming credit is now given to Cuvier [Hardwicke, 1827].

Frédéric Cuvier had received the specimen he described from his brother's stepson, Alfred Duvaucel, who had sent it "from the mountains north of India" [Cuvier, 1829]. He was the first to use both the binomial *Ailurus fulgens* and the vernacular name "panda" in reference to the species in his description published in 1825 in *Histoire Naturelle des Mammifères* [Cuvier, 1825 and NYPL Digital Gallery, 2010]. *Ailurus* is adopted from the ancient Greek word αἴλουρος (*ailouros*), meaning "cat" [Greek Dictionary, 2013]. The specific epithet *fulgens* is Latin for "shining, bright" [Latin Dictionary, 2014]. *Panda* is the French name for the Roman goddess of peace and travellers, who was called upon before starting a difficult journey [Larousse, 1866-77]. Whether this is the origin of the French vernacular name *panda* remains uncertain. In later publications, the name is claimed to be adopted from a Himalayan language.

In 1847, Hodgson described a red panda under the name *Ailurus ochraceus*, of which Pocock concluded it represents the same type as *Ailurus fulgens*, since the description of the two agree very closely. He subordinated both types to the Himalayan red panda subspecies *Ailurus fulgens fulgens* [Pocock, 1941].

### **3.9: CULTURAL ASPECT:**

The red panda was recognized as the state animal of Sikkim, India in the early 1990s [Govt. of Sikkim Report, 2010], and was the mascot of the Darjeeling Tea Festival [IUCN, 1994] and in the logo of PNHZP, Darjeeling they adapt the symbol of red panda as one of their major animal (Fig.: 6).

In 2005, Babu, a male red panda at Birmingham Nature Centre in Birmingham, England, escaped [BBC On-line, 2011] and briefly became a media celebrity [BBC On-line, 2011 and Bounds, 2011], before being recaptured. He was subsequently voted "Brummie of the Year", the first animal to receive this honor [BBC On-line, 2011 and Bounds, 2011]. Rusty, a male red panda at the National Zoo in Washington, D.C., similarly attracted media attention when he briefly escaped in 2013 [Gabriel, 2013 and Day, 2013].

The name of the Firefox web browser is said to have been derived from a nickname of the red panda [Mozilla, 2012 and BBC Nature, 2014].

An anthropomorphic red panda was featured as Master Shifu, the Kung Fu teacher, in the 2008 film *Kung Fu Panda* and its 2011 sequel *Kung Fu Panda 2*. Some of the comments about this film indicate the lack of awareness about the red panda in the United States when the first film was released. Although most of the reviewers got the species correct, some nevertheless mistook it for a tiny wolf [Keller, 2008], a rodent [Boyce, 2008], and a lemur [Pappas, 2008]. In an interview, Dustin Hoffman also indicated he did not know much about the animal when he first agreed to voice the character [Symkus, 2008 and Vigil, 2008]. The red panda Futa inspired the character of Pabu, the so-specified "fire ferret" animal companion (primarily of Bolin) in the animated U.S. TV series *The Legend of Korra* [Konietzko, 2012].

## **4. DISCUSSION AND CONCLUSION :**

The red panda is a carnivorous animal, but this present study and others available literature shows that this animal is also herbivorous as well as rather omnivorous in habit. Red panda's

main diet is bamboo leaves and bamboo shoots in the wild; however, they are adapted to take many other kinds of food materials under captive condition. Interestingly whenever many other types of food, like ripe papaya, banana, sweet bun, apple, raw egg etc. are available to them alongwith bamboo shoot, bamboo leaves etc., they prefer fruits (17%) rather than bamboo leaves (12%). This may be due to long time habit under captive condition generation after generation. Whatever information available for the food habit of red panda in the wild; they can also enjoy available grasses, leaves of other trees, insects, small-sizes mammals etc. as food when bamboo leaves are absent in their habitat.

Whatever paleontological data is available, from that it may be concluded that the red panda is a carnivorous animal but its feeding habit is somewhat not like a typical carnivore. Red Pandas belong to a subfamily within the Ailuridae known as the Ailurinae. Members of this group display a general trend toward hypocarnivory which is reflected by the broadening of their carnassials and posterior premolars with the addition of grinding cusps. These changes were particularly evident in the ancestral *Parailurus* and further emphasized in the modern species. As mentioned above, the Red Panda now a day specialized in eating bamboo. Bamboo is an extremely tough plant with a low nutritional value, and so the Red Panda has had to undergo several cranial and dental modifications to get the most out of this poor diet. The skull has become broader and more domed compared to other ailurines with a pronounced sagittal crest. The premolars have become fully molariform to expand the grinding surface. There is extreme molarization of P4 (upper carnassial) and the additional grinding cusps adapted to crush bamboo. The carnassials have completely lost their shearing function, are much wider than they are long, and have developed multiple enlarged cusps. Endowed with an immensely powerful bite for its size and efficient grinding teeth, red pandas are able to consume large quantities of bamboo per day.

It is unclear exactly when the genus *Ailurus* originated, but it may have descended from the extinct genus *Parailurus* in central Asia sometime during the Pliocene. Other members of Ailuridae became extinct, possibly due to the drastic changes in habitat and climate that occurred toward the end of the Pliocene and continued throughout the Pleistocene. The Red Panda has persisted because it is a specialist, adapted to the temperate high-altitude forests of the Himalayas where it feeds almost exclusively on bamboo.

Breeding of red panda is a grand success at Padmaja Naidu Himalayan Zoological Park, Darjeeling. And feeding is a limiting factor for breeding; therefore, it is obvious that the red pandas of PNHZP enjoy a healthy environment even under captivity.

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## **Understanding Q-M Tunneling and Duality Aspect**

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### **ABSTRACT:**

At the end of 18<sup>th</sup> century some physical problems remains unresolved, among which ultra-violet catastrophe, origin of line spectra of atoms and photo-electric effect are the main. This demands a new formulation of these natural facts. Hence these experimental observations give the birth of the revolutionary concept of quantized energy, introduced by the German scientist Max Plank in 1901. The concept has most challenging conflict with the existing classical concept in exchange of energy, telling that the energy exchange is no-longer continuous but in the form of a particular discrete unit and the amount of energy depends on the frequency of the radiation called quanta. With this theory a concept of energy unit i.e. some kind of particle aspect of radiation comes into account. And the wave particle duality comes in to realization that depending upon the physical event wave can act as particle or vice versa.

### **Introduction:**

The successful overcome from classical physics to a new one is due to Plank's quantum theory introduced to explain where the atomic and sub-atomic structures plays a controlling role in the physical event. Some unsolved problems in physics in 18<sup>th</sup> century were fabulously explained by this theory. The photo electric effect explained by Albert Einstein in 1905, the Compton scattering of X-ray by electrons and some other experiments directly indicates radiation shows purely particle like properties in certain circumstances. This dual nature of electromagnetic radiation is the most striking feature of quantum physics was well accepted but although not understood completely since then.

On the other hand it was in around 1923 matter was believed to be act as particles. Diffraction of electrons by Ni-crystals observed by Davisson and Germar in (1927). Experiment by G.P. Thomson where electrons transmits through a thin poly-crystalline metallic foil and some other experiments imply directly the wave nature of electrons. In that

time (1923-1924) Louis De Broglie, a French scientist introduced a revolutionary concept that a wave is always associated with a moving particle and is called De-Broglie wave. This makes a great unification that they would exhibit dual nature. And the wave-particle duality became a universal characteristic of nature. We want to understand the dual characteristic i.e. the wave particle duality by a single experiment. This is clear that the wave nature of matter is directly related with the finiteness of the Plank constant, indicating that for macroscopic bodies the De-Broglie wavelength is infinitesimally small. And if  $h$  be zero the De-Broglie wavelength also vanishes. Thus as geometrical optics is a short wavelength limit of wave optics, in analogy, the classical mechanics is short wavelength limit of wave mechanics and wave particle duality indicates the applicability of the two mechanics where is to be applied.

### **I. The Wave particle Duality:**

The De-Broglie hypothesis says that any material particles also possess wave-like properties so that like radiation they also exhibit a wave nature. For a free material particle he uses the concept of the properties of the wave packets proposing that for a particle moving with a momentum  $p$  the De-Broglie wave length associated with it is  $\lambda = \frac{h}{p}$  and the frequency is  $\nu = \frac{E}{h}$ . We can see that for photons (E.M. radiation) any one of the relation is sufficient to obtain the wavelength and the frequency, but for material particles one requires both the relations for determining the wavelength and frequency of the De-Broglie wave.

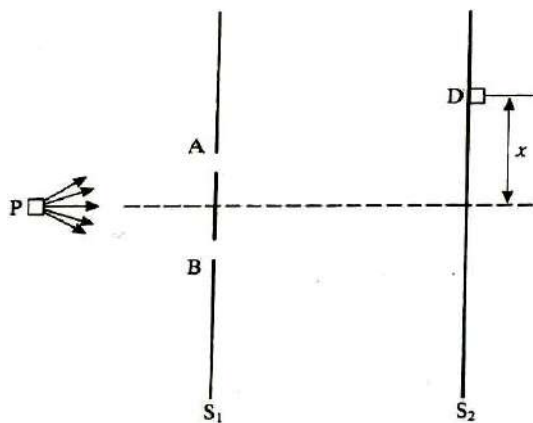
### **II. Application:**

This hypothesis immediately explained qualitatively the quantum condition used in Bohr's one-electron atom model. Consider that the electron in a hydrogen atom revolves around a nucleus in a circular orbit of radius ' $r$ ' and if this orbit is a stationary orbit then accordingly De-Broglie wavelength associated with the electron must be a standing wave i.e, the circumference of the orbit must be an integral multiple of the wavelength which interns indicates the de-localization of the electron in the orbit i.e, the concept of the electron cloud and the idea also obeys Heisenberg's uncertainty principal.

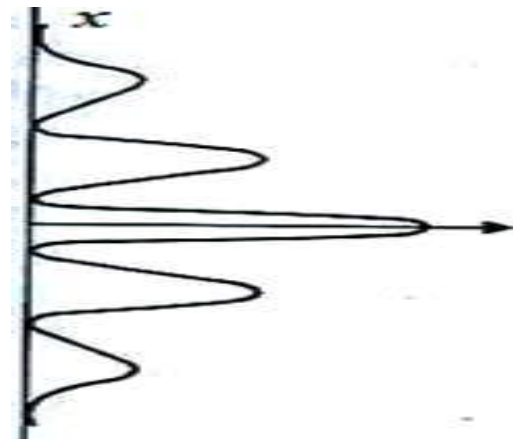
### **Electron diffraction experiment:**

#### **I. The experiment:**

Design an experiment similar to that of the Young's double slit experiment with mono-energetic (similar to the monochromatic light) electrons (materials particles). A mono-energetic beam of electrons from a source (P) is incident on a screen containing two slits A and B. The detector (D) can record the electrons after passing the slits at a particular point. The detector can move over another screen  $S_2$  behind the slits and are such that the electrons can't spread over more than one detector at a particular instant of time, which indicates the localization of mass and the charge electrons after detection i.e, after detection, the electrons appears as purely particle.



**Experimental set up for Young's Experiment with electrons.**



**Distribution of electron intensity for Young's double slit experiment.**

## II. Observations:

A plot of the counts of electrons arriving at the screen in an interval of time as a function of position of the detector is shown in figure (a). Nature of the plot is similar to the intensity distribution of double slit experiment of monochromatic light indicating that the electrons are being diffracted by the two slits i.e, the wave characteristics of electrons. Apparently this may seems that the diffraction pattern is due to the interference between the electrons passing through both the slits. To short out this problem, in 1998 A. Tonomura and their group shows that if the speed of electrons are slow down in such a way that there is not more than one electron between the source and the detector in that particular time to reach the electron from source to the detector. Here also the diffraction pattern still exists but if any one slit of the two slit experiment is closed, the diffraction pattern disappears. This finding signifies an interesting feature inferring that the electrons are not localized before their



detection. i.e, in the case of a single electron it can be considered to pass through both the slits though the electrons are indivisible!

### III. Explanation:

The transiting electrons have a wave property and have particle nature after detection as then they are completely localized. This fact is in contradiction to the classical concept indicating that as the electrons are indivisible, they should pass through either of the two slits. Now to test this first we detect the electrons as they passed through the slit (A). the slit (B) may considered to be closed now as all the particles passes through (A) and the intensity distribution is shown in figure (b). In the reverse case the intensity distribution is shown in figure (c). Now adding the two intensity distributions i.e, when both the slits are open the intensity distribution is shown in

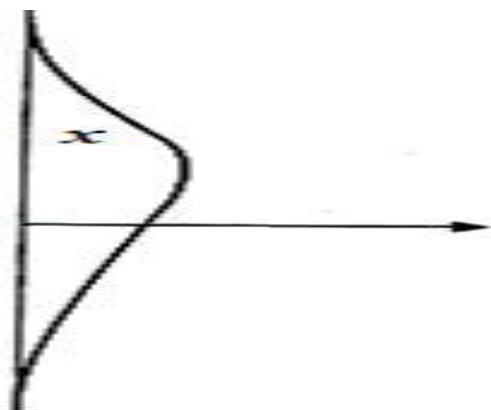


Figure: b.

Distribution of electron intensity for Young's double slit experiment with only slit A is open.

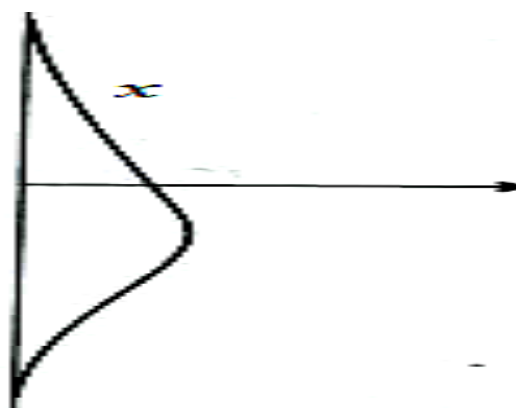
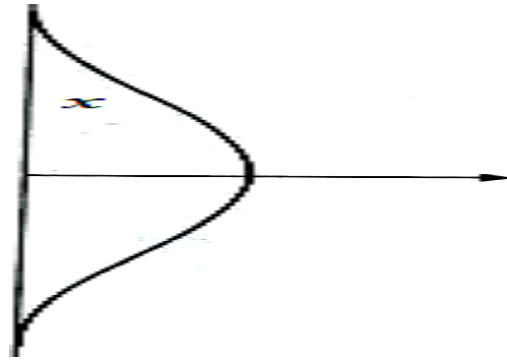


Figure: c.

Distribution of electron intensity for Young's double slit experiment with only slit B is open.

figure (d). This distribution is completely different as that in figure (a), in the case in absence of any information through which slit the electrons transmit. Thus by monitoring the transit path of the electrons, they become a particle and simultaneously can't behave as wave. Thus, the particle aspect and the wave aspect of electrons are complimentary. Now if we consider the case when only one electron transits from the source to the detector with both the slits are open and we have no prediction about the position where the electron should be detected, because this prediction destroys the diffraction pattern. Here we can predict only the intensity distribution i.e, the no of electrons detected at a particular point on the screen  $S_2$



**Figure: d.**

**Distribution of electron intensity by adding intensities in fig B and fig C**

after a large no of individual events. This indicates that for a single electron the process is of statistical in nature. Thus the probability of detecting an electron at a particular point is a measure of intensity. This distribution of intensity with the detector position generates the diffraction pattern of electron reinforcing the wave nature of the electrons.

**Remarks:**

The De-Broglie hypothesis of wave particle duality is applicable for any kind of particle. This uniqueness of the wave particle duality has been confirmed by experiments involving different particles. In 1901 G. I. Taylor confirms this for photons with the diffraction pattern from the shadow of a needle with a very slow source exposed for about a month. This was confirmed in 1989 A. Aspect and his group with more rigorous experimental techniques. I Esterman and his group observed the diffraction pattern of Helium atoms in 1931. Latter the diffraction of neutrons by crystals are also observed which is an extremely useful tool for structural and micro-structural characterization of materials. A. Aspect and his group in the same year proved the validity of wave particle duality for electrons. Very recently in 1991 O. Carnel and J Mlynek observed atomic interference of Helium atoms with Young's double slit apparatus. In all the cases the determined wavelength was found to agree with those obtained from De-Broglie formula.

**So What is Quantum Tunneling?**

Tunneling through a potential energy is a topic routinely investigated in introductory quantum mechanics and provides one of the most striking departures of quantum physics from classical physics. A particle that is bound by some potential is able to escape from the parent system even though it lacks the energy to overcome the attractive force. Classical

physics predicts that such behavior is impossible. So, it is a Consequence of the wave nature of matter. The history of Quantum Tunneling in brief as, It was first used to explain alpha decay of heavier elements in 1928 by George Gamow. And demonstrated experimentally by Leona Esaki in 1958 in the tunneling diode

At the quantum level, matter has corpuscular and wave-like properties. Tunneling can only be explained by the wave nature of matter as described by quantum mechanics. classically, when a particle is incident on a barrier of greater energy than the particle, reflection occurs When described as a wave, the particle has a probability of existing within the barrier region,

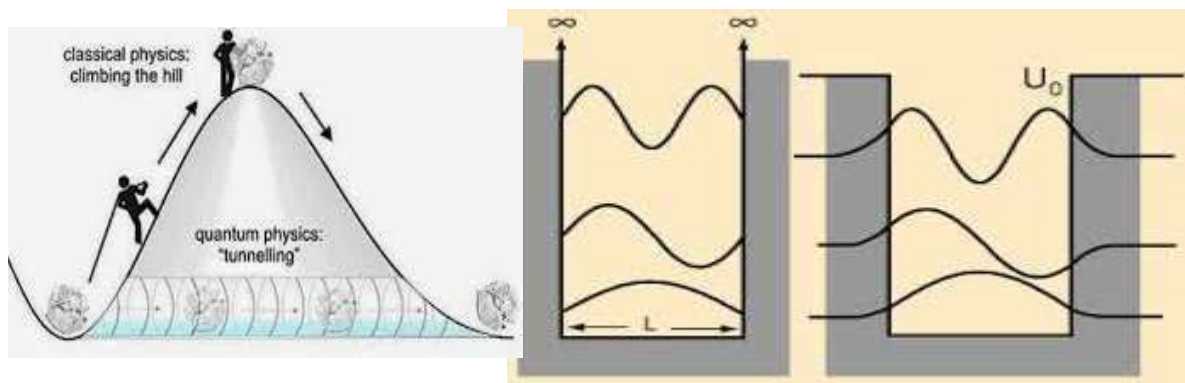


Fig: (a) infinite potential well Fig: (b) finite potential well

and even on the other side of it. For infinite potential height there is no tunneling as shown in fig (a) and in fig (b) there is a finite transmission through the finite potential height. Figure (c) shows the complete tunneling of the incident De-Broglie wave through the finite rectangular

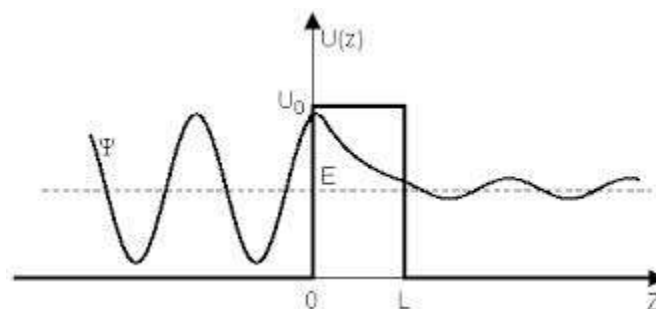


Fig: (c). Finite potential barrier

and even on the other side of it. For infinite potential height there is no tunneling as shown in fig (a) and in fig (b) there is a finite transmission through the finite potential height. Figure (c) shows the complete tunneling of the incident De-Broglie wave through the finite

rectangular potential barrier with a transmission coefficient

$T = \left( 1 + \frac{U_0^2}{4E(U_0 - E)} \sinh^2 \beta L \right)^{-1}$  where  $\beta = \left( \frac{2m}{\hbar^2} (U_0 - E) \right)^{1/2}$ . The following figure (d)

indicates how the transmission coefficient changes along with the classical comparison

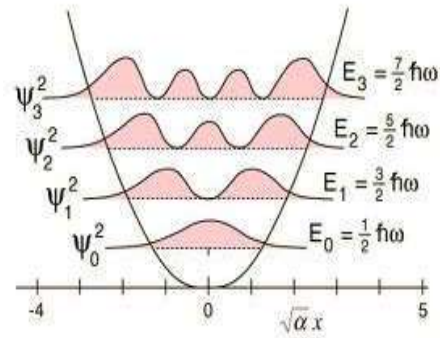
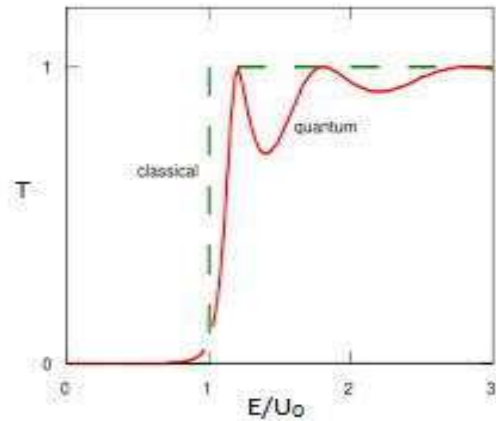


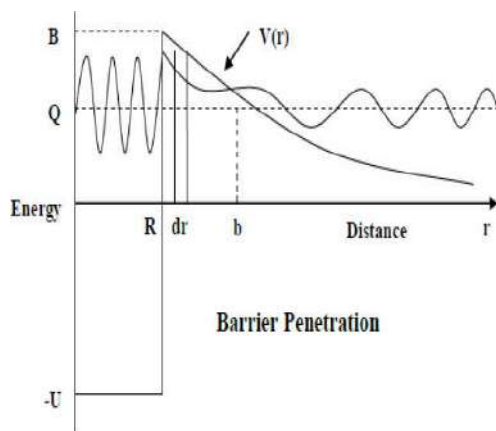
Fig (d). Variation of transmission coefficient for a finite 1-D potential barrier

The Harmonic Oscillator Potential

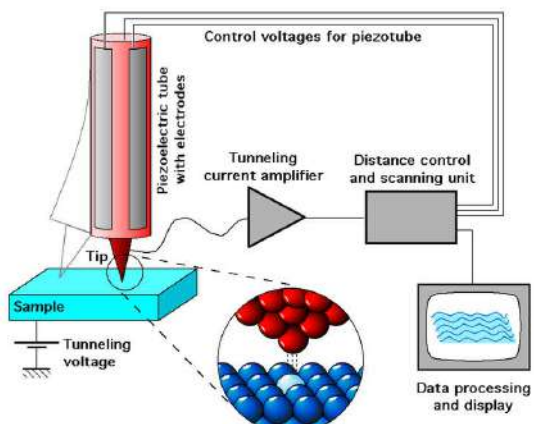
### Some example of tunneling:

#### (A) The $\alpha$ -decay-

However, the ‘fuzziness’ of Nature at the sub-atomic scale that is an inherent part of quantum mechanics implies we cannot know precisely the trajectory of the  $\alpha$ -particle within the nucleus. This uncertainty means the particle has a small, but non-zero probability of suddenly finding itself outside the parent nucleus. We say it has ‘tunneled’ through a potential energy barrier created by the attractive force.



Process of  $\alpha$ -tunneling through the nuclear potential well.



Schematic diagram of STM

### **(B)The scanning tunneling microscope (STM):**

It is an instrument for imaging surfaces at the atomic level. Its development in 1981 earned its inventors, Gerd Binnig and Heinrich Rohrer (at IBM Zürich), the Nobel Prize in Physics in 1986

For an STM, good resolution is considered to be 0.1 nm lateral resolution and 0.01 nm depth resolution. With this resolution, individual atoms within materials are routinely imaged and manipulated. The STM can be used not only in ultra-high vacuum but also in air, water, and various other liquid or gas ambients, and at temperatures ranging from near 0 K to a few hundred K. The STM is based on the concept of quantum mechanical tunneling of electrons. When a conducting tip is brought very near to the surface to be examined, a bias (voltage difference) applied between the two can allow electrons to tunnel through the vacuum between them. The resulting *tunneling current* is a function of tip position, applied voltage, and the local density of states (LDOS) of the sample.

So we can say that the De-Broglie wave associated with the particle tunnels out through a finite potential and after detecting that wave we find the transmitted particle. The particle itself does not tunnel. Thus, if we locate the trajectory of the moving particle we cannot find the wave nature of the particle. i.e. the wave nature and the particle nature cannot be observed simultaneously, they are complementary in nature.

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## **Studies on the Thermoregulatory Behaviour of Flying Foxes at Different Habitats of Purulia District, West Bengal**

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### **ABSTRACT:**

Flying fox, *Pteropus giganteus* is the largest fruit-bat belonging to order Chiroptera of class Mammalia and also is a true flying mammal. The effects of high temperature and associated drought on the behaviour of flying fox colony roosting on different trees of various villages of Purulia district of West Bengal are observed during the hot summer months. The bat population faces no such harm from local villagers. The great threat to these bat populations is high temperature and drought, particularly in the hot months. Maximum temperature of the day reaches upto 50° Celsius and serious drought during monsoon season hit these population of fruit-bats. Fanning, panting, diving at the water surface are general features during the hot months. The average population size of about 250 individuals at some places reached to 80-100 only during June-July of 2013. Repetition of such hot days may abolish these mega-bat populations from this part of the Globe.

**Key words:** Flying fox, High temperature, Thermoregulation, Fanning, Panting, Diving

### **INTRODUCTION:**

There are vital role of climate changes to affecting species abundance, their invasion and extinction (Parmesan and Yohe, 2003; Thomas, 2004). In recent time hot weather events have gained in attention as drivers of broad ecological change (Parmesan et al, 2000). In last 100 years, average global temperature has increased approximately  $0.74 \pm 0.18^{\circ}$  Celsius and presumed to rise at a rapid rate (IPCC, 2007). Temperature extremes that exceeds physiological limits can cause widespread mortality as found in France alone where heat wave in 2003 results more than 15 humans casualties (WHO, 2003). We have very little knowledge about the kinds of effects that high temperature have on biological system.

Flying Fox, *Pteropus giganteus* is the largest species of fruit bats belonging to sub order Megachiroptera, under order Chiroptera of class Mammalia (Neuweiler, 2000; Ali, 2010). Fruit bats forage for fruits, nectar and pollens at dawn and dusk and roosts on camp tree in hundreds during day time. The roosting tree is usually selected on the side of a water body (Dey and Chattopadhyay, 2010; Dey *et al*, 2013). Mega-bats provide important ecological and economic services including pollination of different plants, and also help in seed dispersals (Fujita and Tuttle, 1991; Fleming and Estrada, 1996). Commonly flying foxes roost at outer branches of high trees; hence, they are particularly sensitive to the effects of high temperature. Therefore, the species is convenient indicator for assessing the impact of high temperature on biological system (Welbergen *et al*, 2008).

In this present study the effects of high temperature and drought on the behaviour of fruit-bat and their population density related to this is examined.

#### **MATERIALS AND METHODS:**

There are three study sites, viz. Simla village (under Kashipur block), Bartoria village (under Raghunathpur - I block) and Biltora village (under Neturia block) of Purulia district, a remote and underdeveloped place of West Bengal and about 323 Km. away from the state capital, Kolkata. The flying fox population colonizes at different types of trees like Tamarind tree (*Tamarinda indica*), Arjuna tree (*Terminalia arjuna*) and Eucalyptus tree (*Eucalyptus* sp.), respectively in those three villages. These trees are acts as their camp. At all mentioned three places the camp tree is situated by the side of a large water body. The average population size is 250 with highest during August-September (>250) and lowest during May-June (<90). The bat colonies are not disturbed by the local villagers rather they trying to protect the fruit-bats from the outsiders.

The study is done during the hot months of 2013 through regular visits to the sites, four to six visits in a month. Bat's behaviors during most hot time of the days are observed, and population sizes are recorded.

One Olympus 7 x 25 binocular and one digital camera, Olympus SP-590UZ was used for the study.

## RESULT AND DISCUSSION:

Monthly average temperature (Max/Min) in degree Celsius, population count and dead bats found during the 5 summer months are presented in Table 1.

<b>Table 1: The monthly average temperature (Max/Min) in degree Celsius and the average population count and average dead bats found during the 5 hot months of 2013</b>				
<b>MONTH</b>	<b>AVERAGE TEMPERATURE</b>		<b>AVERAGE POPULATION COUNT</b>	<b>AVERAGE DEAD BATS SEEN</b>
	<b>MAX.</b>	<b>MIN.</b>		
March	39	27	252	02
April	47	34	186	30
May	50	36	93	21
June	49	35	81	06
July	43	27	120	00

In the March, 2013, when temperature is rising then the bats are found to adopt their first two types of thermoregulatory behaviors – wing fanning and seeking shades during mid day to avoid scorching sun light (Fig. 1 and 2). Starting from April and onwards, bats were also seen to panting and diving at water body for soaking their belly (Fig. 3 and 4). When the temperature was reaches maximum and above the tolerance level, they were found to become very lethargic and die either in hanging situation or falls from the camp tree to the ground (Fig. 5 and 6).





[Fig. 1: Fanning by flying fox. Fig. 2: Flying foxes at lower branch of tree to avoid sun light]



[Fig. 3: Panting of flying foxes. Fig. 4: Diving at pond's surface for lowering body temperature]



[Fig. 5: Dead bat hanging on camp tree. Fig. 6: Dead bat falls from tree to the ground]

From this study it is observed that high temperature, beyond tolerance level has intense effect on fruit-bat. At the study area, Purulia district, temperature ranges from 48°/25°C (Max/Min) during summer to 21°/3°C (Max/Min) during winter. Average monthly temperature of the district is purely depending upon rainfall pattern. Absence of proper rainfall and prolonged drought condition during the summer months of 2013 were unusual in last 10 years. Very hot temperature along with drought has caused the mega bats suffer too much including massive death.

Generally, flying fox can maintain their body temperature between 35°C to 39°C. They are less able to protect themselves from overheating because the normal body temperature is close to the lethal value of 44-45°C (Neuweiler, 2000). Flying foxes showing their thermoregulatory behaviors, if the ambient temperature ( $T_a$ ) is above body temperature ( $T_b$ ). These behaviours are adaptive for maintaining body temperature ( $T_b$ ) against ambient temperature ( $T_a$ ). When  $T_a$  (ambient temperature) reaches lethal value, *i.e.*, above 44-45°C no kind of thermoregulatory mechanism is adequate and fruit-bats become lethargic and ultimately death is the destiny.

This study provides an example that how high temperature and prolonged drought may affect the survival of flying foxes. Increasing heat is surely a serious threat to the Indian fruit-bats and the ecological and economical services provided by them (Dey and Chattopadhyay, 2012).

One certainty about our climate is that, it is getting hot. If this is continuing, climate models suggest that once rare heat waves will occur more often and unheard of extremes will strike on occasion (Laurence, 2010). This is matter of worry that if the summer of 2013 repeats in coming days, it will abolish this mega-bat species to extinction from this part of our mother earth.

#### **ACKNOWLEDGEMENTS:**

The author is thankful to the villagers of different villages of Purulia district for providing various known and unknown knowledge about these mega-bat colonies and behaviour. Author is thankful to the D.P.I., Government of West Bengal for his financial support and to Dr. Projjwal Ch. Lama, Officer-in-Charge, Darjeeling Government College, Darjeeling, West Bengal, India for his keen interest in this study.

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## **Antimicrobial Activity of the Alkaloid Fractions of Two Medicinal Plants from Darjeeling District**

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### **ABSTRACT:**

In this study the antimicrobial activity of secondary metabolites mainly alkaloid of two traditional medicinal plants, from different area of Darjeeling Districts, have been studied for their uses in the treatment of infectious diseases caused due to the resistant microorganism, also known as Multi Drug Resistant (MDR) microbes. The sample plants includes Seto chitu (*Plumbago zylénica*) and Chimping (*Heracleum nepalense*). These antimicrobial plants have significant role to neutralize the MDR microbes. Gram positive (*Bacillus subtilis* and *Staphylococcus aureus*) and gram negative bacteria (*E. coli* and *Salmonella typhi*) were used as sample microorganism. The photochemical analysis of sample plants revealed presence of alkaloids, which is significant for the antagonist activity against microbes. The analysis of  $R_f$  values of the bands obtained from the thin layer chromatography (TLC) of the chloroform fraction of each sample plant shows that, out of three sample plants *Plumbago zylénica* is most effective agent against MDR microbes.

**Key words:** Medicinal plants, antimicrobial activity, alkaloids, liquid chromatography.

### **1.INTRODUCTION:**

The medicinal plants have been used from traditional period for curing disease and disorders<sup>1</sup>. In developing countries like India, the economic importance of medicinal plants is much more than in other parts of the world as large population of the country depend on indigenous system of medicine provided by two third of the plants<sup>2</sup>. The rapid increase in multi drug resistant pathogenic microbes have lead to seek for new compounds that are not based on existing synthetic antimicrobial agents which can be isolated from natural sources such as medicinal plants which are safe and inexpensive<sup>3, 4</sup>. The medicinal plants produce a diverse array of secondary metabolites such as alkaloids, saponins, tannins, steroids, glycosides and triterpenoids exhibiting astringent property, antimicrobial activity, anti-

inflammatory and anti-diarrheal properties<sup>5</sup>. One of these components, alkaloids is toxic secondary compound and plays a significant role for the survival of plants against microorganism, insect and against other plants. The alkaloids act by targeting bacterial DNA synthesis essential enzymes such as DNA gyrase and DNA topoisomerase iv<sup>4</sup> or competitively inhibit electron transport in the respiratory chain<sup>6</sup>. The various organic solvent like methanol, ethanol, and hexane are used in the extraction of alkaloids and methanol was found to be the most effective<sup>5</sup>. The antimicrobial assay was done using agar disc diffusion method<sup>7</sup>. Standard antibiotics are used as positive control and the solvents used in extraction of compounds are used as negative control<sup>8</sup>. The results of the antimicrobial susceptibility tests were expressed in terms of minimum inhibitory concentration (MIC), the lowest extract concentration demonstrating no visible growth in the broth minimum bactericidal concentration (MBC), the lowest concentration of the extract at which 99.99% or more of the initial inoculums was killed<sup>9</sup>.

*Plumbago zeylanica* (Plumbaginaceae) root and leaves are used in medicinal treatment for rheumatism, intestinal parasites, anemia<sup>10</sup>. It exhibits significant antimicrobial activity against different pathogenic bacteria with plumbagin showing high activity<sup>11</sup>. *Heracleum nepalense* root crude methanolic extract was found to be active against both Gram-positive and Gram-negative organisms. *Heracleum nepalense* indicate the presence of compounds such as steroids and coumarins and flavonoid, quercetin glycoside, from the plant pharmacological actions such as antioxidant, anticancer, antiulcer, antiinflammatory, antiviral and immunostimulatory activity<sup>12</sup>. Considering the importance of these medicinal plants from traditional system of herbal treatment exhibiting no toxic effect and the approach being inexpensive, we have determined the antibacterial activity of the alkaloid extract of some of the important medicinal plants used by ethnic communities (e.g. Lepchas, Bhutias and Nepalese) of Darjeeling hills. In the present work, a comparative study have been performed for some of the folk medicinal plants in terms of the antimicrobial activity of their alkaloid fraction.

## **2.MATERIALS AND METHODS:**

### **2.1.Plant collection:**

The plant species mainly *Hernacleum nepalense* and *Plumbago zeylanica* were collected from different region of Darjeeling. The inflorescence of former plants and whole plant parts of *Plumbago zeylanica* were used.

## 2.2.Preparation of extracts:

Briefly 10 gm of each plant sample were extracted with 400 ml methanol for 4 h at 150 rpm and after drying in hot air oven the dried plants were made into powdered form. The extracts, after filtration were evaporated and concentrated using rotatory vacuum drier and then dissolved in methanol being stored at  $-20^{\circ}\text{C}$ . The methanol extracts were refluxed with hexane (50 ml) for 3 h. After filtration the residue were discarded and the filtrate was evaporated followed by extraction with diethyl ether (50 ml) for 3 h. After discarding the soluble part the residue portions were triturated with 6 (N) HCl and then using only soluble part. The pH was increased till 9 using aqueous ammonia followed by extraction with chloroform using separating funnel. The chloroform soluble portion were dried and stored at  $-20^{\circ}\text{C}$  for further use. The net weight of all fractionated sample were measured (table 1).

## 2.3.Phytochemical analysis:

The dry weights of fractionated samples were weighed as *Hernacleum nepalense* (2802 mg) and *Plumbago zyleneica* (2963 mg). The presences of alkaloids in individual sample were detected using TLC with dragendroff reagent (50 ml). Individual sample were spotted on TLC plate and placed in 5% ethyl acetate: hexane solution (20 ml) followed by spraying of reagent. The plates were then kept in oven for 2 minutes. The brownish-orange colour band on plate confirmed the presence of alkaloids<sup>13</sup>.

**Table 1:** Net weight of each fractionated plant sample.

Plants	Net weight (g)
<i>Plumbago zyleneica</i>	2.963
<i>Heracleum nepalense</i>	2.802

## 2.4.Test Microorganism:

Bacterial cultures of *Escherichia coli* (MTCC118), *Bacillus subtilis* (DKW1), *Staphylococcus aureus* (MTCC1430) and *Salmonella typhi* (MTCC733). The culture were maintained in nutrient agar slants and stored at  $4^{\circ}\text{C}$ .

## 2.5.Inoculum preparation:

The organisms were inoculated in nutrient broth and incubated at  $37^{\circ}\text{C}$  for 24 h.

## 2.6. Antimicrobial activity:

The disk diffusion methods of (Perez *et al.*1990) were used<sup>7</sup>. The freshly grown bacterial cultures (100  $\mu\text{l}$ ) were spread on Müller Hinton agar plates. The cell concentrations were

found to be  $10^2$ - $10^4$  colony forming unit (cfu)  $\text{ml}^{-1}$  using haemocytometer. The concentrations of stock solution of each plant extract were  $1000 \text{ mg ml}^{-1}$  with working concentration being  $500$  and  $250 \text{ } \mu\text{g ml}^{-1}$  using chloroform as a solvent.  $0.1 \text{ ml}$  of each concentration of plant extract were applied to sterile Whatman No. 1 filter paper disc ( $6 \text{ mm}$ ), dried and placed on the medium plate. The solvent were used as negative control and streptomycin ( $100 \text{ } \mu\text{g ml}^{-1}$ ) was used as positive control. The plates were incubated at  $37^\circ \text{C}$  for  $24 \text{ h}$ . The antimicrobial activities were evaluated by measuring the zone of inhibition against test organism.

### 3. RESULTS AND DISCUSSION:

The chloroform fraction of individual plants when subjected to TLC in a solvent mixture of hexane and ethyl acetate yields band of each two plant extract. The  $R_f$  value for each band of *Heracleum nepalense* and *Plumbago zyleneica* were measured.(table 2).

**Table 2:**  $R_f$  values of different bands obtained.

Plants	$R_f$ value
<i>Heracleum nepalense</i>	0.053
<i>Plumbago zyleneica</i>	0.575

The antimicrobial activity of medicinal plants against various pathogenic bacteria has been demonstrated<sup>14</sup>. The result showed that the extract of the *Plumbago zyleneica* exhibited higher activity against *Staphylococcus aureus* having an inhibition zone of diameter  $10 \text{ mm}$  ( $250 \text{ } \mu\text{g/ml}$ ) and  $13 \text{ mm}$  ( $500 \text{ } \mu\text{g/ml}$ ). In *Escherichia coli* also it exhibited moderate activity with zone of inhibition being  $9 \text{ mm}$  ( $250 \text{ } \mu\text{g/ml}$ ) and  $11 \text{ mm}$  ( $500 \text{ } \mu\text{g/ml}$ ). However it showed low activity in case of *Salmonella typhi* and *Bacillus subtiles*. Thus the chloroform extract of *Plumbago zyleneica* posses broad spectrum activity inhibiting growth of both Gram positive and Gram negative bacteria. The main constituent is plumbagin which is toxic exhibiting relatively specific antimicrobial activity<sup>11</sup>.

*Hernacleum nepalense* showed the zone of inhibition only in *Bacillus subtiles* ( $6$ - $7 \text{ mm}$ ) and *Staphylococcus aureus* ( $1 \text{ mm}$ ), with no activity observed in case of Gram negative group. Streptomycin used as positive control shows higher activity against both Gram positive and Gram negative bacteria while the chloroform solvent used as a control showed zero activity against the entire tested organism. From the present study we can conclude that out of the two

plants used, *Plumbago zylénica* exhibits the inhibitoriest effect against the test microorganism. Hence it provides an encouragement to isolate all the bioactive compounds present in this medicinal plant which can be used for combating various prevalent diseases. The present study suggests the need of deep research to isolate all the bioactive compounds present in the sample plants, which may pave a way to defend human diseases at cheap cost with less toxic effect.

**Table 3:** Antimicrobial activity of tested plants against pathogenic bacteria.

Bacterial Strain	Plants	Inhibitory zone formation (mm)		
		Alkaloid		Streptomycin
		250 ( $\mu\text{gml}^{-1}$ )	500 ( $\mu\text{gml}^{-1}$ )	100 ( $\mu\text{gml}^{-1}$ )
<i>E. coli</i>	<i>H. nepalense</i>	-	3	14
	<i>P. zylénica</i>	9	11	14
<i>S. typhi</i>	<i>H. nepalense</i>	-	-	17
	<i>P. zylénica</i>	9	10	18
<i>S. aureus</i>	<i>H. nepalense</i>	1	1	7
	<i>P. zylénica</i>	10	13	8
<i>B. subtilis</i>		6	7	16
	<i>H. nepalense</i>	8	10	16
	<i>P. zylénica</i>			

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## **Implication of Transcription Factor FoxO3a in Neuronal Death Signaling in a Cellular Model of Alzheimers Disease**

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### **ABSTRACT:**

Massive neuronal loss due to apoptosis is one of the hallmarks of Alzheimer's disease (AD). Transcriptional activation of pro-apoptotic genes is a pre-requisite for variety of programmed cell death. The transcription factor FoxO3a, is an important transcription factor that play important role in cell division, cell differentiation as well as apoptosis. On activation FoxO3a translocates from cytosol to nucleus and induces its target genes. Bim is a pro-apoptotic member of Bcl-2 family which is induced and contributes to neuron death in AD and is a key target of this transcription factor. In this study, we found that exposure of neuronally differentiated PC12 cells to oligomeric beta-amyloid (A $\beta$ ) peptide, the known pathogenic species in AD, results in translocation of FoxO3a from cytosol to nucleus. RNAi mediated silencing of FoxO3a provides protection against A $\beta$  toxicity. FoxO3a knockdown could significantly block the A $\beta$  induced upregulation of BIM. Taken together our findings indicate that FoxO3a is activated, translocated to nucleus and plays a necessary role in neuron death mediated through Bim in response to A $\beta$  toxicity.

**Key words:** Alzheimer's Disease, A $\beta$ , FoxO3a, BIM, PC12 cells, shRNA.

### **INTRODUCTION:**

Alzheimer's disease (AD) is a progressive neurodegenerative disorder and the most common cause of dementia in aged population. This incurable, degenerative and terminal disease was first described by German neuropathologist Alois Alzheimer in 1907. The disease is symptomised by severe memory loss cognitive imparement.

The disease is physiologically characterized by presence of senile plaques of amyloid beta protein (A $\beta$ ) and neurofibrillary tangles of hyper phosphorylated tau protein (3,8). A $\beta$  is believed to be

central to disease pathogenesis. A $\beta$  is a 40-42 amino acid peptide derived from proteolytic cleavage of the amyloid precursor protein (APP).

The underlying cause for the symptoms in AD is the massive neuron death by apoptosis. Researches all over the world are trying to understand the molecular mechanism of neuron death in the disease. For any kind of neuron death transcriptional activation of pro apoptotic genes are needed. FoxO3a is a transcription factor. Recently FoxO3a has been identified as a very important group of transcription factor that modulates the expression of a number of genes involved in cell differentiation, resistance to oxidative stress, DNA damage repair, cell cycle arrest and apoptosis(1,7). FoxO3a belongs to 'O' subclass of Fox super family of transcription factors. They are conserved from worms (*Caenorabditis elegans*) to mammals(2).FoxO3a is highly expressed in brain tissue.

The transcriptional activity of FoxO3a is modulated by its sub cellular localization (4). Generally FoxO3a in its inactive form localizes in cytoplasm of the cell and upon activation translocate to the nucleus of the cell. Once in nucleus, FoxO3a induces the transcription of its target gene. In the present study we investigated the role of FoxO3a in a cellular model of Alzheimer's disease.

## **METHODS AND MATERIALS:**

### **CELL CULTURE:**

PC12 cell was cloned in 1976 from a transplantable rat pheochromocytoma. They :

- a) Synthesize, store, release and take up considerable levels of chatecholamines,
- b) Manifests features of sympathicoblasts, the cells that give rise to postmitotic sympathetic neurons.
- c) Respond to nerve growth factor(NGF)and acquire many characteristic properties of sympathetic neurons. In response to NGF there is cessation of proliferation, generation of neuritis, appearance of electrical excitability, hypertrophy. The widespread utility is due to its relative stability, homogeneity, high degree of differentiation and robust response to NGF.

PC12 cells were culture as described (6). In brief, they were maintained in DMEM medium supplemented with 10% heat inactivated horse serum and 5% fetal bovine serum in 37<sup>0</sup>c incubator and under 5%CO<sub>2</sub>. The cells were passaged on confluency.

The PC12 cells were plated in 6 well plates with 2 ml complete medium per well. 24 hours after plating the complete medium was aspirated out and the differentiating medium was added which contained DMEM supplemented with 50ng/mL nerve growth factor (NGF), 1% heat inactivated horse serum and penstrep. The medium was changed on every alternative day. Differentiation was complete in 5-7 days.

### **ASSESSMENT OF CELL SURVIVAL BY TRYPAN BLUE EXCLUSION ASSAY:**

Trypan Blue is a vital dye. The dye exclusion test is used to determine the number of viable cells present in a cell suspension. It is based on the principle that live cells possess intact cell membranes that exclude certain dyes, such as trypan blue, whereas dead cells do not. Cells were detached by gentle pipetting . Cell suspension and 0.4% Trypan Blue solution was

mixed in 1:1 ratio. Allowed to stand for 5 min at room temperature. Trypan blue/cell suspension mixer was taken on a hemocytometer. Live (Colourless) and dead (blue) cells were counted under phase contrast microscope .Percentage of viable cells were calculated.

### **PREPARATION OF AMYLOID BETA (AB):**

HPLC-purified A $\beta$ <sub>1-42</sub> was purchased from American Peptide and oligomeric A $\beta$ <sub>1-42</sub> was prepared. lyophilized A $\beta$ <sub>1-42</sub> was reconstituted in 100% 1,1,1,3,3,3 hexafluoro-2-propanol (HFIP) to 1 mM, HFIP was removed by evaporation in a Speed Vac, then resuspended to 5 mM in anhydrous DMSO. This stock was then stored in -80 C. The stock was diluted with PBS to a final concentration of 400  $\mu$ M and SDS was added to a final concentration of 0.2%. The resulting solution was incubated at 37°C for 18-24 hrs. Again the preparation was diluted with PBS to a final concentration of 100  $\mu$ M and incubated at 37°C for 18-24 hrs before use.

### **TRANSFECTION:**

PC12 cells were plated in 24 well plates (over cover slips for ICC) or 6 well plates (for western blotting) with 10% confluency and then differentiated. On the third day of differentiation the cells were transfected. Transfection was done using lipofectamine following the manufacturer's protocol. 0.5  $\mu$ g of plasmid DNA was used for transfection of each well of 24 well plates. In case of six well plate it was 2  $\mu$ g per well. 48 hours post treatment transfected cells were treated with 6-OHDA.

### **IMMUNO- CYTOCHEMICAL STAINING:**

Neuronal PC12 cells were grown on glass coverslips for 6 days before experiment. Cells were treated with or without AB for overnight. Then cells were then processed for immunocytochemical assay (ICC). Briefly, Few drops of 4% PFA was added in the medium containing cells. It was kept for 5 minutes at RT. After that the medium was aspirated out and 4%PFA was added to the cells. Again it was incubated for 20 minutes at-20<sup>0</sup> C. It was washed twice with phosphate buffer saline (PBS). Then the coverslips were blocked by 3% goat serum in PBST (T refers to triton X). Blocking was done for 1- 2 hours.Then primary antibody was added in blocking solution.It was incubated overnight at 4<sup>0</sup>C.It was then washed with PBST 3 times for 5 minutes each.Then secondary antibody was added in blocking solution (1 to 1and half hours) at RT.Again the cells were washed with PBST thrice for 5 minutes each.Then cells were stained with Hoechst for nuclear staining followed by rinsing with water. Immunostained cells were imaged under fluorescence microscope.

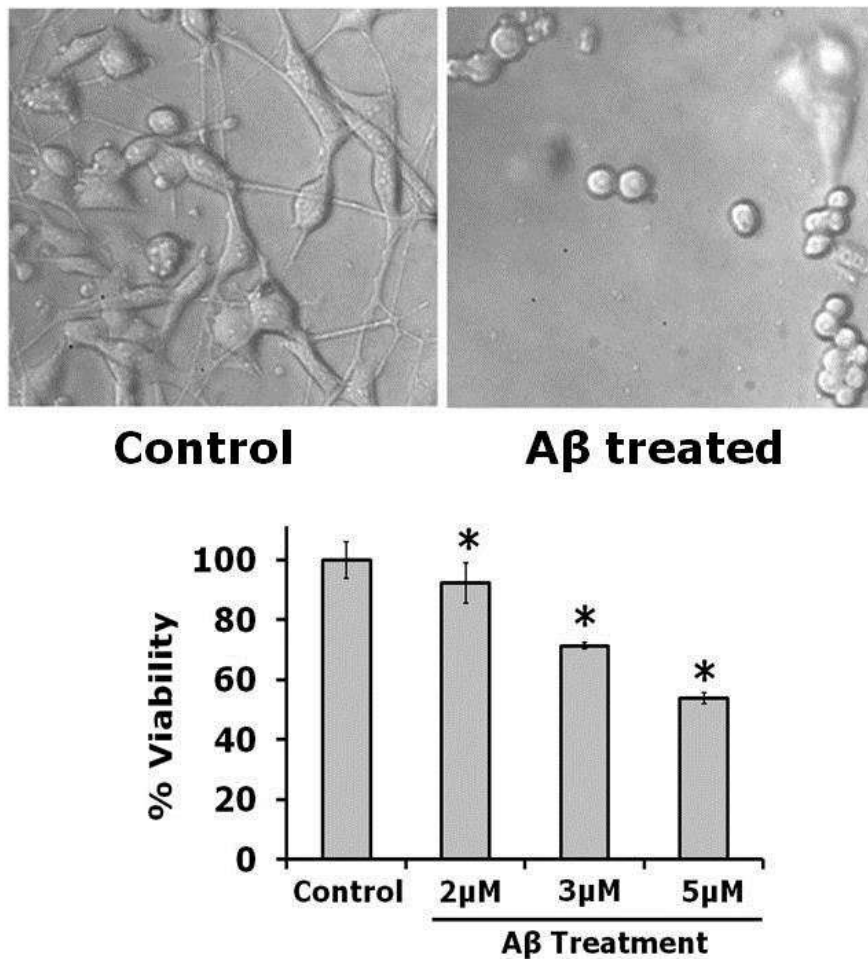
### **RESULTS:**

#### **Developing a cellular model of Alzheimer's Disease**

To develop the model we have employed neuronally differentiated rat PC12 cells followed by oligomeric A $\beta$  treatment. This is been widely used worldwide as a cellular model of Alzheimer's Disease. PC12 cells are neuro precursor cells which can be differentiated into neuronal cells by applying Nerve growth factor(NGF).

It is believed that oligomeric A $\beta$  protein which is deposited in the brain of Alzheimer's patient is toxic and cause neuron death in the disease. We treated the neuronally differentiated PC12 cells with different doses of oligomeric A $\beta$ . The cell survival was assessed after 24hours by trypan blue exclusion assay. Results show that percentage of viable

cells were significantly reduced to about 81%, 60%, 30% at concentration of 3, 5, 10  $\mu\text{M}$  of  $\text{A}\beta$  respectively (Fig 1). For the following experiment we have used 5  $\mu\text{M}$  of  $\text{A}\beta$ .

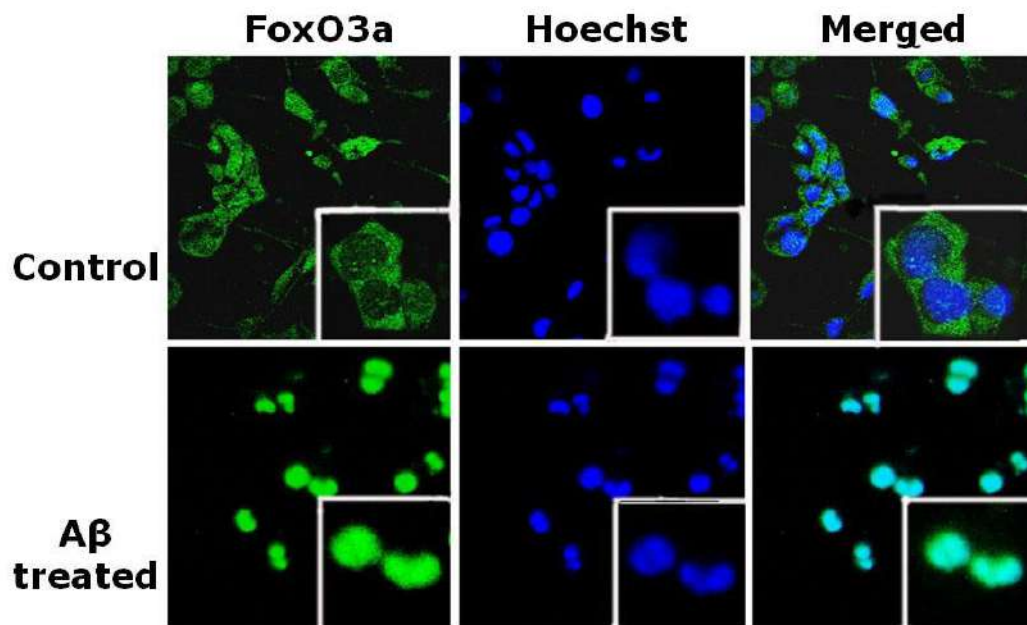


*FIG 1: Differentiated PC12 cells were exposed to different concentration of  $\text{A}\beta_{1-42}$  for 24 hours. By trypan blue exclusion assay the viability of cells were checked. Upper panel: Representative phase contrast micrograph of neuronal PC12 cells in absence and presence of  $\text{A}\beta$  are shown. Lower panel: Viability of cells progressively decreases with increased concentration of  $\text{A}\beta$ . Data represented as mean  $\pm$  SEM of two experiments performed in duplicates. Asterisks denote statistically significant difference with control, \* $p < 0.05$ .*

### **FoxO3a translocates from cytosol to nucleus in the AD cellular model.**

It has been reported in different disease models that sub cellular localization of FoxO3a is an indication of its activity. Generally FoxO3a in its inactive form is present in the cytoplasm and upon activation translocates to nucleus. So we wanted to check the localization of FoxO3a in the cellular model of AD. For this the neuronally differentiated PC12 cells were treated with AB for 16h. The cells were then immunostained using FoxO3a primary antibody and green fluorescence tagged Alexa flour 488 as secondary antibody. Result showed the

presence of FoxO3a in the cytoplasm as indicated by green colour. Interestingly, following A $\beta$  treatment the FoxO3a translocates to nucleus. The nucleus was stained with a dye called Hoechst, which can be visualized as blue colour under UV filter of fluorescence microscope. Thus our result indicates that FoxO3a is activated and it translocate from cytoplasm to nucleus in the cellular model of AD.



*FIG 2: Differentiated PC12 cells were maintained in absence and presence of A $\beta$  for 16 hours. Cells were then fixed and immunostained with FoxO3a antibody and nucleus were stained with hoechst. Localization of FoxO3a was studied using fluorescence microscopy.*

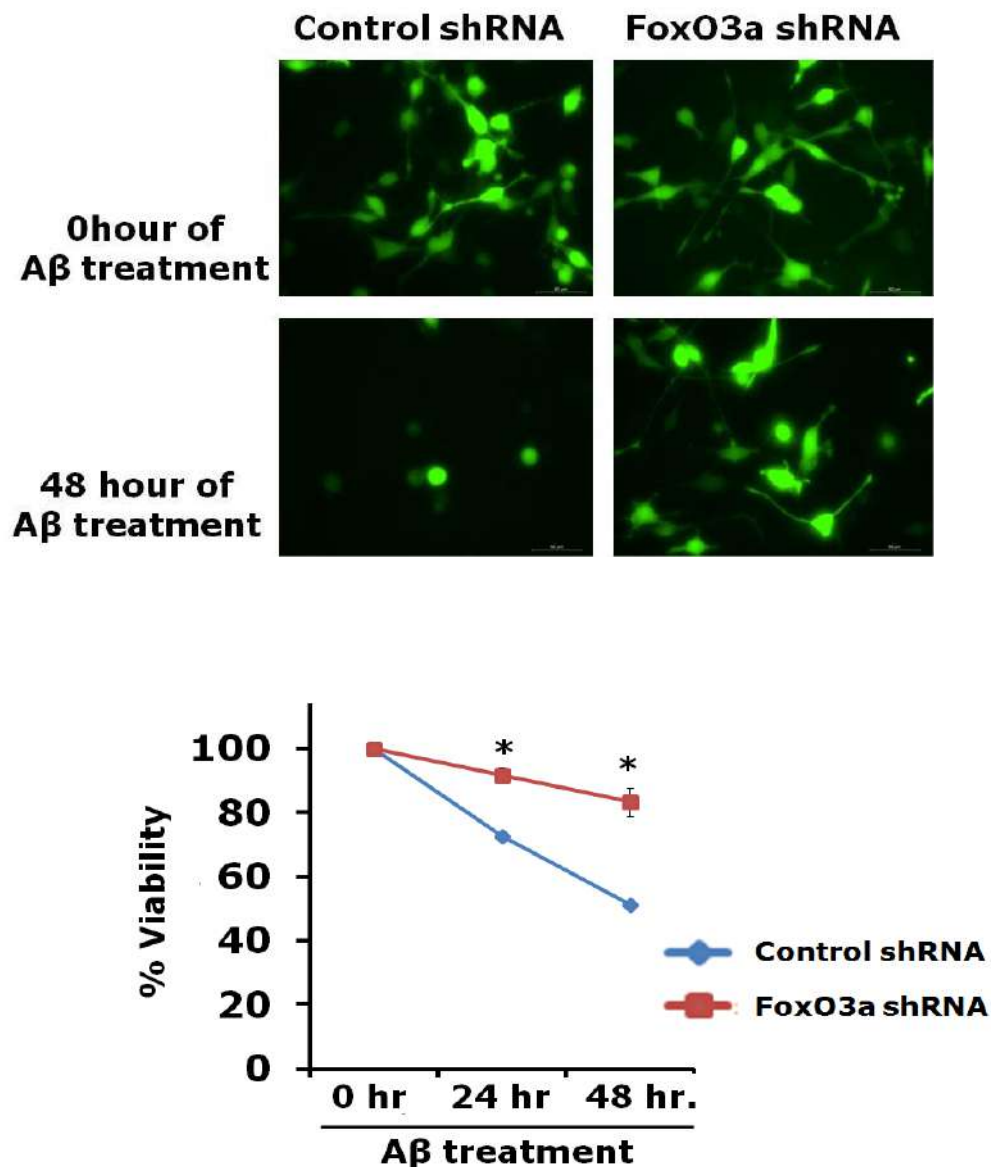
### **Knocking down FoxO3a by shRNA protects neuronal PC12 following A $\beta$ treatment.**

We next wanted to find out whether FoxO3a is necessary for neuronal cell death in cellular model of AD. For this we used shRNA mediated knockdown of FoxO3a. shRNAs are short hairpin RNAs which are exogenous RNAs of about 20-30 nucleotide long and can bind to FoxO3a mRNAs by complementary base pairing resulting in the degradation of FoxO3a mRNA. Degradation of FoxO3a mRNA results in a reduced FoxO3a protein level and thus knocking down or silencing of FoxO3a.

We transfected neuronal PC12 cells with either shFoxO3a (a shRNA capable of knocking down FoxO3a) or a control shRNA. The transfected cells were maintained for 48h, allowing the expression of the shRNAs and successful knockdown of the respective proteins. Transfected cells were then treated with or without A $\beta$  for 24 and 48h. Result (Fig:) shows that the cells where FoxO3a were knocked down were significantly protected from A $\beta$  induced cell death. Whereas, the control shRNA transfected cells undergo significant death following A $\beta$  treatment.

Gene silencing of FoxO3a not only protects neuronal PC12 cells against A $\beta$  but also retains the neuronal morphology (that is long processes from the cell body) even after 48h of A $\beta$  treatment (Fig:3).

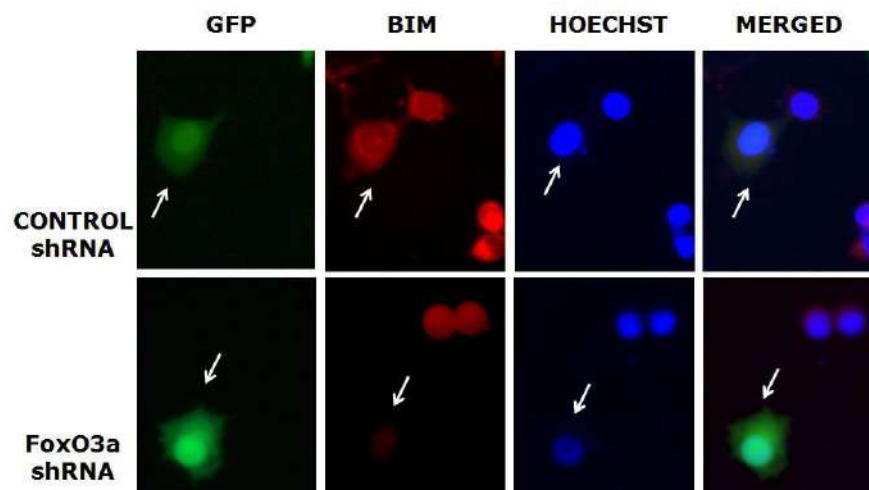
Thus our result shows that FoxO3a plays a necessary role in neuronal cell death in the cellular model of AD and that silencing of FoxO3a could protect the cells significantly.



*FIG 3: Differentiated PC12 cells were transfected with control shRNA and shFoxO3a GFP. 48 h post transfection A $\beta$  was treated for 48 hrs. Live green cells were counted at indicated times under fluorescence microscope. Upper panel: Representative pictures of differentiated PC12 Cells transfected with control shRNA and shFoxO3a GFP and exposed to A $\beta$ . Lower panel: Graphical representation of percentage of viable cells. Data represented as mean  $\pm$  SEM of three experiments. Asterisks denote statistically significant difference with control, \*  $p < 0.01$ .*

**FoxO3a knock down blocks A $\beta$  induced upregulation of proapoptotic gene ,BIM.**

It has been previously reported that a proapoptotic protein BIM is upregulated in the brain of AD patient (9). Bim is a member of intrinsic pathway of apoptotis. FoxO3a is a transcription factor which can bind to the promoter of Bim and control its transcriptional activity. So we wanted to examine whether FoxO3a regulate Bim expression in our model. For this neuronally differentiated PC12 cells were transfected with FoxO3a shRNA that substantially reduced the expression of FoxO3a in cells. A control shRNA was also transfected. With this setup the immuno cytochemical staining for Bim was done after treating them with A $\beta$  for 24 hours. Result shows that cells having FoxO3a shRNA has a reduced level of Bim even in presence of A $\beta$ , as compared to the neighboring cells. The control shRNA transfected cells did not show such change in Bim level. The cells that are transfected are visualized as green because the shRNAs were cloned in plasmids that have green fluroescence tag. For immuno fluorescence staining of Bim, the secondary antibody is tagged with red flurophore. Our result thus indicates that knocking down FoxO3a could successfully block the A $\beta$  induced upregulation of Bim.



*FIG 4: shRNAs targeted to FoxO3a block Bim expression in differentiated PC12 cells subjected to A $\beta$  toxicity. It shows neuronal PC12 cells that were transfected with the indicated constructs maintained for 48 hrs and then subjected to A $\beta$  for 20 h after which they were immunostained with antibodies against Bim (red). Transfected cells are green and nucleus is stained with Hoechst. Arrows indicate the transfected cells.*



## DISCUSSION:

In the study we studied the role on transcription factor FoxO3a in neuronal death signaling in a cellular model of Alzheimer's disease. We initially established the cellular model by treating neuronally differentiated PC12 cells with amyloid beta protein. In our model we found that FoxO3a is activated and translocates to the nucleus. There are previous reports that FoxO3a is activate by a number of post translational modifications ultimately resulting in its translocation to nucleus. Through the use of gene silencing which may have eventual utility in AD treatment (5), we show that transfecting FoxO3a shRNA in the differentiated PC12 cells prior to A $\beta$  exposure significantly increases cell viability. This indicates that FoxO3a plays a necessary role in neurodegeneration.

The pro-apoptotic protein Bim has been reported to be upregulated and play necessary role in neuronal cell death in the Alzheimers disease. FoxO3a is a transcription factor and Bim promoter has a binding site for the transcription factor FoxO3a. In different cellular model system the expression of Bim is reported to be controlled by FoxO3a. We in our experiment found that Bim is upregulated in neuronal PC12 cell in response to A $\beta$  treatment. But interestingly if FoxO3a is silenced by siRNA the A $\beta$  induced upregulation of BIM could be successfully blocked. This indicates FoxO3a regulates the expression of BIM in our model. even though we found that BIM is regulated by Foxo3a there may be other transcription factors as well which play important role in this death signaling pathway. It would be interesting to study the role of other proteins regulating this death signaling pathway in neurons. FoxO3a being a transcription factor can control a number of genes, it will be interesting to investigate the role of FoxO3a in regulating the genes of extrinsic pathway of apoptosis which are also activated in the AB treated neurons.

In summery our result supports a model where the transcription factor FoxO3a translocates into nucleus following AB treatment and play a necessary role in AB induced neurodegeneration. Within the nucleus FoxO3a activates BIM, a member of intrinsic apoptotic pathway. This opens a new avenue in identification of new therapeutic targets in Alzheimer's disease.

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## Treasure in the Ants Nest

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### ABSTRACT:

Probably ants are the most ancient architect of world. The nest not only provides the ants with security and defense against enemies but creates an extraordinary *microenvironment*. Pedobiologists (soil scientists) has drawn special interest on the million years old biological evolution of ant-nest soil due to its remarkable and distinguishable characteristics. Nest construction solely depends on the variety of ants, especially on the activity of worker ants.



*Ant nest*

A remarkable increase in the mineralogical properties of mounds built by ants is found in grassland area. Arboreal ant nests, particularly nearby orchards are claimed as significantly richer in phosphorous (upto 348% richer than their corresponding adjacent soils) where as leaf-cutter and seed-harvester ant nest soil are rich in carbon and nitrogen. The enriched concentration in mineral nutrients (e.g.,  $\text{NH}_4^+$ ,  $\text{NO}_3^-$ ) and exchangeable cations (e.g.,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ , and  $\text{Na}^+$ ) makes the ant nest soil exceptionally fertile (Wagner *et al.*, 1997; Wagner *et al.*, 2004). The wood ants, commonly found in forest ecosystem, have a significant

influence on the physical, chemical and biological properties of the soil. They change the physical properties of the soil by transporting lower soil layers to the upper surface. Furthermore, the foraging behavior of ants make the soil having greater proportions of silt-sized and clay-sized to the detriment of coarse-sized particles and fine-sand-sized particles and lower the bulk density relative to the adjacent soils. The chemical content of the nest material is modified by the excrements the ants produce, as well as by the residuals of their nourishment and by the transportation of organic material which occurs as they are building their nests. Thus a considerable amount of nutrients (P, N, K etc.) is concentrated in their nests. Along with greater mineralization and nutrient availability, enhanced water holding capacity, better levels of infiltration has been observed in the nest of ants dwelling in desert watersheds compared with adjacent non-nest soils and it is irrespective of ant species or landscape position. Interestingly, all most all kind of ant-nest soils show neutral pH and comparatively lower temperature in summer. Lower temperature is probably caused indirectly by soil aeration by ants at and around their nest.

And thus extraordinarily nutrient rich microhabitats are developed by ants and these biogeochemical hotspots support unique microbial assemblages (Hasin *et al.*, 2014). The common microbial association is found bipartite in nature. However, ants, its ‘fungal garden’ or farm, especially of leaf-cutter ants (*ant-fungi mutualism*) and the protecting filamentous actinomycetes on ant cuticle – these three (ant, fungi, and bacteria) make an exclusive tripartite association (Zhang *et al.*, 2007) and considered as the most primitive one (Leal *et al.*, 2014). The fungal cultivars, serving as the primary food source for the ants, are carefully manured by the ants with plant materials, insect frass, or seeds. Foundress queens propagate the fungus by carrying inocula in their mouths during their flight to establish new colonies. Ant’s farms are usually protected by antimicrobial chemicals, different types of antifungal antibiotics and herbicides synthesized by pet bacteria. The organic compounds secreted by the metapleural glands of ant itself are also important to remake their habitat (Meer *et al.*, 1998). The secretion grouped in seven classes: acetic acid, short chain acids, medium chain acids, long chain acids, indoleacetic acid (phytohormone), g-lactones and g-ketoacids like 3-hydroxydecanoic acid. Formicine ants of Amazon rain forest synthesize formic acid which act as herbicides, allow only specific plants to survive in their nest environment.

Apart from the bacteria producing antimicrobial components, other microbes having properties like ammonia-oxidation, nitrogen-fixation, phosphate solubilization, starch and cellulose hydrolyses etc. support the nutritional facility to fungi and thereby ants as in a symbiotic community. Ant’s agriculture concerned with the fungal crop, application of

protective measure and required 'NPK' manure which are indeed comparable with human farming. Hence, an important research area that has yet to be explored concerns the effect of ants at various spatio-temporal parameters of the ecosystem.

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## **Relationship with Coal Quality and Thermal Power Plant Performance: A Review**

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### **ABSTRACT:**

Coal which is the main fossil fuel in Thermal Power Plant is formed in the earth's crust, from the decayed plant remains beneath the Earth for millions of years through a complex chemical and physical change. There are different grades of coal namely- Anthracite, Semi-Anthracite, Bituminous, Lignite, Peat etc. according to their carbon content. There are several factors viz., moisture, volatile matter, ash, fixed carbon, gross calorific value etc. which are responsible for the quality of coal used for Thermal Power Plant. For high moisture (M) content in coal trouble starts at the mill where the coal is pulverized, high M leads to sticking of fine particles and air is then not able to carry the pulverized coal to the boiler, resulting to the overloading and tripping of the mill. If we use more hot air (flue gas) to the mill then air/coal ratio increases which reduces the efficiency of combustion. Besides high M leads to corrosion of the entire system as it combines with  $\text{SO}_x$  &  $\text{NO}_x$  to form acids which mainly corrodes the economiser tubes. Again high volatile matter (VM) in the coal represents high content of hydrocarbons which gives bright and inconsistent flames of higher temperature which leads to the deformation of the waterwall tubes and subsequent tube leakage. But as hydrocarbons leads to high heat formation so coal with high VM is always preferable. Another negative point is that high VM coal is always associated with high M content resulting to the same problems associated with moisture. Ash (A) is not directly involved but affects the combustion process by disturbing the furnace stability. High A leads to slow burning so the combustion takes place at super heater zone resulting to boiler tube leakage, clinkering do occur in this zone followed by dropping of large rocks leading to damage of the waterwall tubes. Besides high A coal leads to high ash content in the flue gas which leads to failure of the electrostatic precipitator (ESP) forming high suspended particulate matter (SPM) through the chimney thus violates the emission norms of Central Pollution Control Board

(CPCB). Another parameter is fixed carbon which is the remaining part of coal when all the above M, VM, A is subtracted. As the FC increases all the M, VM, A decreases and high FC coal is very less abundant and is used in steel industry thus limiting it to be used in thermal power plant. Coal having higher Gross calorific Value (GCV) is always the preferred coal which is to be used in Thermal Power Plant. So we can conclude that it is the quality of coal which governs the performance of a thermal power plant.

**What is Coal?** Coal is the Earth's crust, formed as a result of accumulation of decayed plant remains millions of years ago and its subsequent consolidation over the years by a complex series of chemical and physical change.

### **SEYLER'S classification of coal**

Types Of Coal	Carbon Percentage
i)Peat	<75
ii)Lignite	75-84
iii) Bituminous	84-91
iv) Semi-Anthracite	91-92.5
v) Anthracite	> 92.5

### **Parameters of quality of Coal & their Determination**

i)Moisture(M)    ii)Volatile Matter(VM)    iii)Ash(A)    iv)Fixed Carbon(FC )    v)Gross Calorific Value(GCV)

#### **i) Determination of Moisture (M)**

Loss of weight of a known weight of coal sample (-212 $\mu$  size) after heating in an oven at 105-107°C for 2 hours (or till constant weight) expressed as percentage. Moisture percentage =  $(W_2 - W_3) \times 100 / (W_2 - W_1)$ , where  $W_1$  = weight of empty petridish,  $W_2$  = weight of petridish + wet sample,  $W_3$  = weight of petridish + dried sample.

#### **ii) Determination of Volatile Matter (VM)**

The loss of weight (excluding loss of moisture) of a known weight of a coal sample (-212 $\mu$  size) heated in a covered crucible in a muffle furnace at 900°C for 7 minutes expressed as percentage. VM Percentage =  $(W_2 - W_3) \times 100 / (W_2 - W_1) - M$ , where  $W_1$  = weight of empty VM

crucible,  $W_2$  = weight of VM crucible + sample before heating,  $W_3$  = weight of VM crucible + sample after heating,  $M$  = Moisture percentage.

### **iii) Determination of Ash (A)**

It is the weight of the residue remaining after heating a known weight of coal sample (-212 $\mu$  size) in a muffle furnace at 815°C for 2 hours (or constant weight) expressed as percentage. Ash Percentage =  $(W_3 - W_1) \times 100 / (W_2 - W_1)$ , where  $W_1$  = weight of empty silica dish,  $W_2$  = weight of silica dish + sample before heating,  $W_3$  = weight of silica dish + sample after heating.

### **iv) Determination of Fixed carbon (FC)**

Fixed Carbon Percentage =  $100 - (M + A + VM)$ , where  $M$  = Moisture %,  $A$  = Ash %,  $VM$  = Volatile Matter %

### **v) Determination of Gross Calorific Value (GCV)**

Determined in Bomb Calorimeter. A Known amount of the sample is burnt the Bomb in oxygen atmosphere. The bomb is placed in a calorimeter. The amount of heat produced on burning the sample is equal to heat absorbed by the calorimeter. With the knowledge of water equivalence of the calorimeter and correct measurement of rise in temperature by Beckmann Thermometer on burning the coal sample, heat of combustion can be calculated. Nowadays fully computerized and automated Bomb Calorimeters are available.

### **Effect of Coal Quality on Combustion**

- ⊙ **Moisture-** For high moisture content in coal trouble starts at mill where the coal is pulverized. Higher moisture leads to sticking of fine particles and air is not able to carry the pulverized coal to the boiler. So the roller of the mill starts overloading and tripping of mill occurs. If we flow more hot air to the mill which is nothing but the flue gas then air/coal ratio increases which reduces the efficiency of combustion. Besides high moisture leads to corrosion of the entire system as it combines with  $SO_x$  &  $NO_x$  which are formed in the boiler to form acids which mainly corrodes the economiser tubes and the lifetime of the economiser tube reduces.



- ◎ **VM-** Composition of VM is mainly Hydrocarbons and high volatile matter (VM) in the coal represents high content of hydrocarbons (mainly methane which is popular to us as coal bed methane) which gives bright and inconsistent flames of higher temperature (methane has heat of combustion value = 839 KJ/mole) which leads to the deformation of the waterwall tubes and subsequent tube leakage. But as hydrocarbons leads to high heat of formation (carbon has heat of combustion value = 394 KJ/mole which is nearly the half value of heat of combustion value of methane = 839 KJ/mole) so coal with high VM is always preferable. Another negative point is that high VM coal is always associated with high M content resulting to the same problems associated with moisture.
- ◎ **Ash-** Ash (A) is not directly involved but affects the combustion process by disturbing the furnace stability. High ash leads to slow burning so the combustion takes place at super heater zone (where tubes are not thick) and leads to boiler tube leakage. Clinkering (association of smaller particles to a bigger ones) do occur in this zone followed by dropping of large rocks leading to damage of the waterwall tubes. Besides high ash coal leads to high ash content in the flue gas which leads to failure of the electrostatic precipitator (ESP) forming high suspended particulate matter (SPM) through the chimney thus violates the emission norms of Central Pollution Control Board (CPCB).
- ◎ **Fixed carbon-** As the FC increases all the M, VM, A decreases and high FC coal is very less abundant and is used in steel industry thus limiting it to be used in thermal power plant. In this connection it is to be remembered that high FC coal have low GCV as carbon combustion has low value which restricts to be used in thermal power plant.
- ◎ **GCV-** High GCV coal is always preferable. Thus the Performance of a Thermal Power solely depends upon coal quality.

Here are some typical values of Coal Mines of India of which the coals are used for Thermal Power Plant's in India.

Coal Mines	M	VM	A	GCV
B.C.C.L.	Moderate	Moderate	Moderate	Medium
C.C.L.	Low	Low	High	Low
E.C.L.	High	High	Low	Medium

**Conclusion-** So from the above discussion we can conclude that it is the quality of coal which governs the performance of a thermal power plant.

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