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HERITAGE

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Editorial

Inheritance of academic discourses is the objective of Heritage. Present issue is also a continuation of previous. Twelve papers were included in the Volume VII extending diverse research and reviews. In a detailed review by Prof. Krshna Roy on Osteoporosis, '*Osteoporosis at a glance: A General awareness of the Disease*' explained every aspects of the disease in a perfect amalgamation of recent concept and general awareness. Another review by Tania Upadhyay, Dr.Smita Ray and Dr.Sritama Mukherjee on rice research, '*Agronomic Advancement of Rice: A Review*' has showcased recent achievements in the field. Synthesis and characterization of luminescent materials for optoelectronic components and devices was reported in the paper '*Many facets of reactions of thiocyanate anions with bare and complexed copper (II) ions*' by Dr. Supriti Paul and Prof. Debashis Ray. Paper titled '*Avian diversity in pond ecosystems*' by Seemanti Chatterjee & Dr.Bhabani Shankar Joardar explained the complex network among living resources, habitats and nature. Next research paper titled '*Effect of sublethal doses of Cypermethrin on the haemocytes of Periplaneta americana (Dictyoptera: Blattidae*)' by Dr. Hiroj Kumar Saha & Romi Ghosh are reporting dose dependent toxicity of pesticides. Yearlong survey on Goat rumen flukes was reported in the paper '*Prevalence of Paramphistomosis in and around Santiniketan, Birbhum, West Bengal*.' by Dr. Sutapa Datta. Agro-economic prospect of shrimp culture was reflected through the paper titled 'Shrimp *cultivation and the prospect of household earnings in a village of Sunderban*' by Karabi Mahato and Dr. Adrita Chakrabarti.

Air-breathing teleosts of the Indian subcontinent are unique among freshwater teleosts in having a very active urea cycle, the capacity to switch from ammoniotelism to ureotelism under hyperammonia stress and during exposure to air, they have the capacity to tolerate very high ambient ammonia. *'Change in activity of Ornithine-Urea cycle enzymes in Channa punctatus under hyperammonia stress*'.by Paramaa Raha confirmed that *C. punctatus* is capable of stimulating ureogenesis, by inducing the already existing functional urea cycle both in hepatic as well as some non-hepatic tissues, thus turning from ammoniotelism to ureotelism as one of the major physiological strategies to avoid the accumulation of toxic ammonia to a lethal level. Glutamate synthetase located in the astrocyte, usually detoxify ammonia through binding with glutamate to glutamine. During elevated expression of glutamate synthetase, astrocyte undergoes morphological changes initiating astrocyte swelling. Another paper by Piyali Roy Chaudhury, Parama Raha and Samiran Ghosh, titled '*Ammonia induced Astrocyte swelling in C. punctatus '* reporting the histological evidence of ammonia induced astrocyte swelling..

In the Social Science and Humanities section, we have three papers from different disciplines. Article by Amrita Bagchi on '*The Developmental Phase of Private Health Care Sector: History of Nursing Homes in the Early Years after Independence in Kolkata.'* discusses the emergence and role of private health care sector (nursing homes) in a newly independent city. Small nursing homes played a dominant role in providing inpatient care to a large section of population in the pre globalized age which witnessed the corporatization of health care services. The next paper is an interesting one from the discipline of Library Science, titled '*Preparation of a bibliography on and by Pandit Iswar Chandra Vidyasagar: an informetric analysis***'** by Partha Chattopadhayay. The year 2019 was the 200 years of birth anniversary of Pandit Iswar Chandra Vidyasagar. The author makes an attempt to create a bibliography on Vidyasagar touching every aspects of his life. The paper titled '*A Comprehensive Study of Lux Soaps in India: Negotiating Gender and Advertisements.'* by Sarita Mal highlights the challenging role of advertisement industry in media. The paper throws light on the notion of gender and how it is intertwined with the mythical concept of beauty which is being now shaped by the advertisements.

Continuous nurturing by our Principal, Prof Krishna Roy only makes this endeavor successful. We are thankful to all Reviewers for their sincere contribution during peering. We also convey best wishes to all contributors. We would also like to thank the journal committee members for their unstinted efforts.

Amrita Bagchi,

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Samiran Ghosh

Osteoporosis at a Glance: A General awareness of the Disease.

Krishna Roy

Professor of Physiology & Principal, Bethune College.

Abstract: Osteoporosis is a pervasive multi-factorial chronic disorder, characterized by low bone mineral density and increased risk for bone fragility, with a claim for long term management procedure. Osteoporosis as a disease in general is a major threat due to our changed life style and aging demographic. It may be viewed as a heterogeneous condition which may occur due to various genetic, nutritional, mechanical, endocrine and other life style factors. Although post- menopausal women are the most vulnerable victims, aged men population cannot escape themselves from this disease, as can be diagnosed by Bone Mineral Density (BMD) test. The disease can be controlled by change in life style along with usage of some selected pharmaceuticals and nutritional supplements. Hence assessment of the prevalence and awareness of the risk factors associated with the disease may provide the basis of management and future health plans to combat it.

Key words: *Osteoporosis, BMD, Risk factors. Post menopausal women.*

Introduction:

Osteoporosis, a silent debilitating chronic disease, demands the second most important position in the global health care arena (2). In 2013, sources estimate that 50 million people in India are either osteoporotic (T-score lower than-2.5) or have low bone mass (T-score between-1.0 and-2.5) (43). Studies indicate that osteoporosis and osteopenia or low bone mass may occur at a relatively younger age in Indian population (44, 45). It is characterized by low bone mass with altered micro-architecture of the bone that leads to increased risk of fragility of bones (10). Conventionally, osteoporosis has been classified into primary and secondary osteoporosis. Primary osteoporosis refers to osteoporotic conditions which are not related to other chronic illnesses and is usually associated with aging and decreased gonadal function, such as decreased level of oestrogen, whereas secondary osteoporosis is the type of osteoporosis caused by other health problems. Disuse is one of the many reasons inducing bone loss and resulting in secondary osteoporosis (24). The disuse osteoporosis refers to decrement of bone mass under certain conditions such as decreased mechanical loading, including decreased ground force reaction, muscular contraction. It is also found in microgravity-related bone loss in astronauts after space flights. Disuse osteoporosis is found in a regional way, mostly in the areas with tremendous decrease in weight bearing like lower limbs. In daily life, bones of lower limbs are subjected to mechanical stimulations provided by static gravity-related weight-bearing, ground reaction forces, and dynamic loading

generated by muscle contractions during locomotion. Physical exercise is also essential for increasing or maintaining bone mass and strength (25.) In post menopausal women, Milliken et al. (26.) have investigated the effect of one-year supervised weight training exercise on their bone mineral density (BMD) level. The study result showed higher BMDs of trochanter and femoral neck in women with weight training exercise than in those lacking exercise. Similarly, Chan et al. (27), have studied the effect of Tai-Chi exercise on the bone quality in postmenopausal women. In fact, there are many effective treatments available for control of primary osteoporosis, but effective treatments for disuse osteoporosis is still to be discovered. This is because of the fact that the aetiology, patho-physiology, and resultant pathology of disuse osteoporosis differ from those of primary osteoporosis.(32)

Osteoporosis as a disease in general is a major threat due to our changed life style and aging demographic.(11). An analogy may be drawn with respect to asymptomatic condition of hypertension, and dyslipidaemia which culminates in stroke or myocardial infarction, osteoporosis may similarly predispose to multiple fractures in the bones of the body (10). Although the disease prevails in the post- menopausal women population due to their decreased bone mineral density (BMD) resulting from deficiency of female sex hormone, it has found to touch the male population also (2). Thus osteoporosis has always been mislabelled as a women's disease by the public, but it really affects men, too. Usually, young patients if afflicted by the disease, remain undiagnosed until a fracture brings the patient to a doctor. As a major public health problem, it is often associated with the incidence of bone fractures which lead to morbidity specially among older population, culminating in mortality also. It is true for the entire population of the world also. The disease is also associated with a huge financial burden even in the developed countries (10). Indeed it is a multi-factorial disease, easily affected by a number of risk factors that influence Bone Mineral density or B.M.D. (6, 10). Unfortunately this important health hazard though known for a long time, has received a low level of attention in primary health care program in most of the under developed countries, where specifically most of the women though vulnerable to this disease are almost unaware of the graveness of the disease (1). Naturally, they are also quite in the dark about the remedial measures to be adopted as a part of their lifestyle. The present article aims at reviewing the basic information of the disease, current prevalence and awareness of osteoporosis not only among the women population, but also in the male community in the perspectives for this particular health hazard.

Aetiology:

Osteoporosis may be considered as a heterogeneous condition which may express at any age of life and is attributed to various factors, such as advancing age, physical disability, genetic, endocrine, nutritional, metabolic, mechanical factors as well as deficiency of Immune system of the body (4, 10). These may again be categorized as non- modifiable and modifiable factors. Non- modifiable factors include genetic pattern, age, sex, physical structure and modifiable factors are usually body weight, life style factors specially sedentary life style or exposure to microgravity etc. (32).

A. Genetic factors:

Gene for vitamin D receptor is believed to be a determinant factor for bone mass and difference in VDR gene polymorphism in different races may be responsible for difference in bone mass (7). This has been significantly shown in Indian women (8). Moreover, oestrogen receptor α (ER α) gene polymorphism may also be associated with B.M.D. in Indian women (8). Other gene, i.e. collagen type Iα1 gene and Insulin like growth factor I(IGFI) gene , (specially in men have proved their role in earlier studies(2, 15).

B. Nutritional factors:

Bone health depends much on Calcium and Vitamin D status in the body and thus deficiency of these two factors seems to be the major contributing factors for osteoporosis. Apart from body weight, age and menopausal state, Calcium intake is found to be an important determinant of BMD (10). Similarly, low level of serum Vitamin D is associated with low B.M.D. status (17)

C. Hormonal and Metabolic factors:

Medical conditions like hypogonadism, thyrotoxicosis, Adrenal cortical disorder like Cushing Syndrome, Chronic Inflammatory conditions, and, Anorexia nervosa, Renal disease, Chronic liver disorder, malabsorption syndrome, may lead to osteoporosis. (21,32)

D. Level of Peak bone mass achieved at puberty:

This is usually achieved by proper nutrition and physical exercise (4).

E. Medications:

Use of drugs in the group of Glucocorticoids, Antilipidemics etc may lead to Osteoporosis (9). It may be called as secondary osteoporosis.

F. Osteoporosis due to Disuse of body components: It is in general bone loss or a reduction of bone mass in relation to bone volume, while the ratio of bone mineral to collagen remains unchanged. The loss of trabecular bone is more rapid and dramatic, while the cortical loss continues for a longer period (28). However, during long term bed rest, paralysis, bones of lower limbs are subjected to three categories of mechanical loadings during daily life, namely, static gravity-related weight bearing, ground reaction forces, and dynamic loading generated by muscle contractions during locomotion. Different health problems are associated with absence or decrease in one or more of these mechanical stimulations and may result in bone loss differently in anatomical location, quantity, velocity, and through different mechanisms. Several studies on effects of microgravity on skeleton, i.e reduced weight bearing and ground reactions focused on the impacts on skeletons of astronauts after spaceflights. Collet et al. (29) analyzed the BMD and biochemical parameters of 2 astronauts who stayed one and six months, respectively, in

space. However, the impacts of microgravity on human skeletons are highly varied, but in case of astronauts it is to be noted that muscle contractions are not limited or restricted.

Epidemiology:

There is no doubt that Human population of all races and ethnicity is susceptible to osteoporosis. Worldwide, life time risk for osteoporotic fractures in women is 30-50% and 15-30% in men (12.) Based on 2001 census, it was postulated that by 2015, Indian aged population (age above 50 years) **would become 230 million from 130 million when 20% of women and 10-15% of men population would be osteoporotic (10**). The National Health and Nutrition Examination Survey (NHANES) III data had shown that prevalence of osteoporosis is highest in older White women, followed by Mexican American women and finally by Black women as based on B.M.D. estimation of femur (8). In current Indian context, it appears from the situation analysis of the elderly in India, most common disability among the aged population is the locomotor disability which may arise due to osteoporosis (5,45) . In USA, Osteoporotic fractures are extremely common, with an estimated figure of 1.5 million people suffering from fragility fractures each year. A similar burden of disease was also observed in the UK, with epidemiological studies hypothesizing that one in two women and one in five men aged over 50 years will suffer an osteoporotic fracture in their lifetime.(47).

Pathogenesis of Osteoporosis:

Our Bone continually undergoes modelling (during growth) or remodelling (during adult life), and this is brought about by the co-ordinated action of two types of cells, osteoblasts and osteoclasts. Osteoblasts form new bone, whereas osteoclasts are responsible for bone resorption. Both types of cell exert their actions being under hormonal regulation. Osteoporosis, is a condition when bone resorption exceeds bone formation leading to a reduction in bone mass, which again predisposes to fracture. The most important cause of osteoporosis is oestrogen deficiency which results in increased bone turnover in which resorption exceeds formation. Corticosteroids can also induce osteoporosis in which trabecular bone is particularly affected. This mainly results from suppression of osteoblastic activity. (46) Pathogenesis of Osteoporosis unlike other chronic diseases is rather complex. Its prevalence is associated with genetic and other risk factors. Peak bone mass of an individual attains a maximum value after sufficient deposition of bone mineral and skeletal growth. The process slows down after adulthood. Thereafter, bone resorption process begins to exceed bone formation. As cancellous bone is metabolically more active than cortical bone, during accelerated bone loss, cancellous bones become three fold more osteoporotic and the result is evident in the important cancellous bone like vertebrae (19). Regulation of bone turn- over is influenced by hormones, physical activity, nutrition, age and genetic factors.

Osteoporosis is conventionally classified into two main groups by considering the factors which affect bone metabolism: Primary osteoporosis and Secondary osteoporosis.

Primary osteoporosis is again sub- divided into two groups:

a). **Involution or Type I Osteoporosis**: It is also known as postmenopausal osteoporosis, as it is mainly caused by the deficiency of female sex hormone oestrogen. Oestrogen mainly affects the trabecular bone. As a result, women are more susceptible to osteoporosis than men and it is evident by a men/women ratio of 4/5.7(30)

(b) **Involution or Type II Osteoporosis**: Also known as senile osteoporosis, and it is related to loss of bone mass during aging of cortical and trabecular bones (41, 42)

Secondary osteoporosis: is mediated by:

Different diseases such as Vitamin D deficiency, Vitamin A excess, different medications, specially, those used for treatment of acidity, (Aluminum in antacids), anxiety reliever drugs, sedative drugs (Barbiturates,) Anticoagulants (heparin), Anticonvulsants, Cancer chemotherapeutic drugs, Depomedroxyprogesterone (premenopausal contraception), Glucocorticoids (≥5 mg/day prednisone or equivalent for ≥3 months), GnRH (gonadotropin-releasing hormone) agonists, Lithium Cyclosporine A, Tacrolimus, Methotrexate, Parental nutrition, Proton pump inhibitors Selective serotonin reuptake inhibitors, Tamoxifen® (premenopausal use) Thiazolidinediones, Thyroid hormones (in excess)etc and lifestyle changes such as , high salt intake, alcohol abuse, low calcium intake , physical immobilization, low physical activity, can cause secondary osteoporosis(40)

Diagnosis:

Osteoporosis is a silent disease since it does not show any symptom until a fracture occurs. Hence, the bones become so weak that sudden strain, bump or fall causes vertebrae to collapse or a hip fracture. If vertebrae collapse, it initially exhibits back pain, followed by loss of height, spinal deformities such as kyphosis or stooped posture, Major signs of osteoporosis are sloping shoulders, curve in the back, loss of height, back pain, hunched posture,, protruding abdomen etc (22). Osteoporosis affects all bones of the body , though breakage is common in hip, wrist and spine.(23). The gold standard for the diagnosis of osteoporosis is by measuring B.M.D. using DEXA (Dual Energy X ray Absorptiometry) at different indicative sites such as lumbar spine, femoral neck and total hip. Using the guidelines of WHO , osteoporosis is believed to be present if t- score of B.M.D. is at least more than 2.5 S.D. below the peak bone mass of reference standard for young white women(2,18). The most important question here arises regarding the appropriateness of Western standard in case of Indian Population, since B.M.D.at all the sites seems to be 5-15% lower than the Caucasians (3). A few years ago, The International Society for Clinical Densitometry (ISCD) recommends using ethnic- or race-adjusted Z-scores: Z-scores of −2.0 or lower are defined as “low bone mineral density for chronological age” or “below the expected range for age” and those above −2.0 are defined as “within the expected range for age” (33) Bone mineral density though can be easily measured to detect bone density, but the degree of deterioration of the bone tissue cannot be measured in clinical settings, except for the biochemical markers of bone tissue (34). Bone remodeling (or turnover) occurs throughout

our life to repair small or minimum fatigue damage and microfractures in the bone and to maintain mineral homeostasis. Biochemical markers of bone remodeling include some resorption markers, namely serum C-terminal telopeptide type-I collagen (s-CTX) and urinary N-telopeptide (NTX), and formation markers, such as serum procollagen type-I N-terminal propeptide (s-PINP), which may provide information on fracture risk independent of BMD and predict the rapidity of bone loss in untreated patients.

Following studies are also necessary to rule out secondary osteoporosis (40):

Complete blood count (CBC), Serum creatinine, calcium, phosphorus, and magnesium,

Alanine aminotransferase (ALT), aspartat aminotransferase (AST), and alkaline phosphatase (AP) Thyroid-stimulating hormone (TSH) and free T4, Vitamin D (V-D) (25 (OH) D, Parathyroid hormone (PTH), Total testosterone and gonadotropin in younger men, BTMs

Remedial Measures for prevention and treatment of osteoporosis:

Osteoporosis is a preventable and treatable disease but because of lack of warning signals, people are not aware or nor being diagnosed in time to receive effective therapy during the early phase of this disease. So universal recommendations for all patients are:

1. An adequate intake of calcium and Vitamin-D, through natural / artificial sources
2. Life- long regular weight-bearing and muscle-strengthening exercises.
3. Treatment of risk factors for falling
4. Cessation of tobacco use and excess alcohol intake

On top of that it is to be remembered that low serum calcium levels promote bone resorption and calcium requirements increase among older persons; thus, the older population is particularly susceptible to calcium deficiency. Moreover, all calcium preparations are absorbed adequately if taken along with food, particularly in the absence of the secretion of gastric acid. For optimal absorption, the amount of calcium should not exceed 500–600 mg per dose. A few foods are rich in oxalate, and they prevent absorption of calcium by binding with it. On the contrary excess intake over and above 1200–1500 mg/day may increase the risk of developing kidney stones, cardiovascular diseases, and strokes. Calcium absorption is assisted by Vitamin D. Chief dietary sources of V-D include V-D–fortified milk, juices and cereals, saltwater fish, and liver. Supplementation with V-D_2 (ergocalciferol) or V-D_3 (cholecalciferol) may be used. Many older patients are at a high risk for V-D deficiency, which include the following: patients with malabsorption issues (e.g., celiac disease) or other intestinal diseases (e.g., inflammatory bowel disease, gastric bypass surgery); gastric acidity; some anticonvulsive drugs); or glucocorticoids, which decrease calcium absorption; housebound and chronically ill patients; persons with limited sun exposure; individuals with very dark skin; and obese individuals. Therefore, Serum 25 (OH) D levels should be measured in patients at the risk of V-D deficiency. V-D

supplements should be recommended in amounts sufficient to bring the serum 25 (OH) D level to approximately 30 ng/mL (75 nmol/L)

Treatment with Pharmacological agents: Pharmacological interventions are often required specially for persons with high risk of osteoporotic fractures

The main objectives of this therapy in osteoporotic patients are to improve quality of life through

- Prevention of fractures by improving bone strength and reduction of the risk of falling and injury
- Maintenance of normal physical function and relief from fractures and physical deformity

In fact, most of the current therapies in the prevention of osteoporosis and fractures are designed to arrest bone resorption and increase bone mass and these are known as antiresorptive agents. Some important agents in this group are oestrogen; **Bisphosphonates (BPs)** such as alendronate, risedronate, ibandronate, and zoledronic acid; other drugs are Selective Estrogen Receptor Modulators (SERM)-such as Raloxifene;another one is Human Monoclonal Antibody against receptor activator of NF-κB ligand (RANKL): Denosumab; and Strontium Ranelate (SR). Of all these drugs Bisphosphonates are the most widely used drugs for the treatment of osteoporosis. Bisphosphonates are a group of **drugs** that work by slowing bone loss. They reduce the risk of hip and spine fractures. Bone renewal is a slow process, but in many people an increase in bone density can be measured over five years of treatment. Alendronate is used in the prevention and treatment of postmenopausal, glucocorticoid-induced, and male osteoporosis cases. Zoledronic acid is used for the prevention and treatment of postmenopausal osteoporosis and osteoporosis in men as well as glucocorticoid-induced osteoporosis.). Ibandronate is another BP used for the prevention and treatment of postmenopausal osteoporosis, which has proven efficacy in reducing the risk of spinal fractures of postmenopausal women suffering from osteoporosis, but it is not proven in reducing non-vertebral or hip fractures except for higher-risk subgroup. Ibandronate has been studied in trials of up to 3 years and its efficacy and safety beyond 3 years is not known (43).

Biphosphonates are the main drug of choice for the usual case of reducing the risk of mild to moderate fractures in vertebrae or non vertebral regions, while for severe osteoporosis use of teriparatide is the answer.(38,39). Teriparatide (recombinant human PTH 1–34) with all its adverse effects has been selected as a drug of choice specially for post menopausal women with a high risk of fracture, and those who have failed or are intolerant to previous osteoporosis therapies. It is also used to increase bone mass in men with idiopathic or hypogonadal osteoporosis. Denosumab (human monoclonal antibody against RANKL) as a new drug is considered as a drug of choice for the treatment of postmenopausal women at a high risk of fracture and also for patients having a history of

osteoporotic fractures, or patients who have failed or are intolerant to other available osteoporosis therapies.

Pharmaceutical vitamin D (D3) or its precursor alfacalcidol are approved drugs for treatment of osteoporosis but not for prevention for which Cholecalsciferol is more effective (38)

Researchers in this field opine that at the foremost, life style of an individual is to be modified. We must create general public awareness in this regard. This awareness program must convey a few important points to the susceptible persons, such as a brief idea about B.M.D., importance of regular exercise, consumption of Calcium and Vitamin D rich foods, building up of strong bones at childhood, frequent exposure to Sun light, and special awareness programs are also to be made for post menopausal women. Apart from these, avoidance of high salt diet, coffee, and alcohol consumption and cigarette smoking, indulgence in regular physical (weight bearing and muscle strengthening) exercise, intake of balanced diet with adequate calcium and Vitamin intake.(35) Another cheap but useful therapy recommended is daily exposure of skin to sunshine for at least 15 minutes (37). It is also important to motivate our children to drink milk and to enjoy playing under the sun. People with sleep- apnoea are found to be victims of osteoporosis, since oxygen depletion can weaken bones (36).

Conclusion:

Many of us are aware about the disease Osteoporosis. We are also aware of the fact that worldwide osteoporosis causes a significant amount of people to suffer from fracture due to osteoporosis and it correlates to an osteoporotic fracture every 3 seconds. Every year, we consider 20th October as world osteoporosis day. The severity of the disease is increasing with the increase in ageing population throughout the world. Understanding the reasons behind the multi-factorial nature of bone health, preventive care towards control and mitigation of the problems underlying Osteoporosis must be given due importance and this can only be achieved with the adoption of changed life style, dietary habit, appropriate low cost medicines and genuine, constructive awareness about this debilitating disease.

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The Developmental Phase of Private Health Care Sector: History of Nursing Homes in the Early Years after Independence in Kolkata.

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Abstract: The paper begins by examining the global trends in health policy and the perceptions obtaining in India in the early years of Independence. However, the main focus of this paper is to trace the growth of private medical establishments in Kolkata from the 1940s to early1990s. Basing on interviews and oral sources of a wide cross-section of health workers, this study tries to tell the story of causes, development and characteristics of the nursing homes in pre liberalisation era in Kolkata. The story is brought down to the early 1990s when the era of corporate healthcare made its beginning. The paper ends with providing some insights on the current position of the small erstwhile popular nursing homes in a globalised metropolis.

Key Words: *private health care, nursing homes, government, pre liberalisation, doctors.*

Introduction:

A substantial part of the private healthcare sector existed between 1947 and the pre-liberalization era. But neither in India, nor in most other developing countries, was there any governmental policy directed towards the promotion of private healthcare. It is only in the recent past that the policies promoted by the World Bank and other international organizations have placed a high priority upon the increasing role of this sector, especially in the developing countries.

In most of the developing countries, even a few decades back, the government was viewed as the sole player in the healthcare sector. The International Conference on Primary Health Care, Alma Ata, in 1978, strongly reaffirmed that health was a fundamental human right and that the attainment of the highest possible level of health was a most important world-wide social goal whose realization required active inputs from many other social and economic sectors in addition to the health sector. The primary position of the government, at least in the policymakers' eyes, was confirmed by the influential Alma Ata declaration, which viewed the government as the major vehicle for improvement in people's health status. However, a great deal has been researched and written about the performance of the public healthcare providers but similar knowledge on the private health sector has only begun to emerge over the last few years.

A.Jesani and S.Anantharam have correctly pointed out that the private sector and relevance of privatization policies in the healthcare services are perhaps the least studied areas in our

country. It is therefore amply clear that the policy of turning a blind eye to the private healthcare sector has created a monster which is eating away a big chunk of India's valuable resources.

The idea of calling upon private capital for financing healthcare was first clearly articulated in the document *'Financing Health Care: An Agenda for Reform'* (World Bank 1987), which set the policy agenda for the late 1980s. However, the importance of the private health sector was recognized properly only after the publication of the *World Development Report* (WDR) *1993*: Investing *in Health*. This was actually a manifestation of the trend towards international mobilization around the theme of a smaller role for the government in healthcare.

Global policymakers have tended to recognize the *WDR 1993* as the 'starting point' for recognizing the private healthcare sector as a major component of health services. What is significant is that private healthcare which had existed in the form of small nursing homes and clinics (in the early years after Independence, in case of India) was overlooked completely by international agencies and global policymakers.

Against these backdrop, the present paper intends to trace the growth of small nursing homes and their changing profile in Kolkata in the decades following independence and more precisely in the pre Liberalisation era.

Private healthcare existed substantially prior to globalization. In the pre-globalization-liberalization era, private healthcare was confined almost entirely to secondary level healthcare. Post-reform policies or more precisely globalization provided the platform whereby private and corporate players were allowed large-scale entry into tertiary level healthcare. And herein lies the significance of post-liberalization privatization. Since tertiary level healthcare involves multi speciality hospitals, privatization in this domain implies large-scale influx of corporate capital. Thus as opposed to pre-liberalization private healthcare, post-liberalization privatization is in essence corporatization. From now on, healthcare would flaunt itself quite unabashedly as a purely business proposition where the profits would mostly come from the upwardly mobile social strata, in place of the nationalist and leftist image of healthcare as a service for all the people

Tracing the History of Nursing Homes in the early years after Independence: Causes, Development and Charecteristics.

There is a serious paucity of data regarding the nature or even size of the private health sector. The government documents have not recorded its growth and there seems to be almost deliberate silence on documenting the rise of the private health sector.As there is a lack of historical records in this regard, oral sources or interviews were used to weave the story of the growth of nursing homes in Calcutta. This survey is based entirely on interviews with the physicians, managers or administrators and sometimes of the nurses and attendants of the nursing homes. The nursing homes that are unevenly distributed all over Kolkata were chosen on a random basis

It is necessary to mention that the private nursing homes, in the early period after Independence, did not mushroom due to any global drive towards privatization. Nor was it due to so much dismal performance of the public sector. The real impetus towards setting up of nursing homes sprang from a number of causes. First and foremost was the need, felt by somewhat affluent middle-class families, of getting more personalised care than was possible in government health establishments. Secondly, there was among physicians a set of entrepreneurs who felt the drive to address this need. But, the whole thing operated at a rather small scale. The nursing home was in many ways an extension of the doctor's private practice. Hence, the nursing homes often had a personal touch; sometimes the patients' meals would be cooked by the doctor's wife or at least the cooking supervised by her.

Under the West Bengal Clinical Establishments Act of 1950, it is mandatory for all nursing homes to get registered. However, the list of registered nursing homes available with the state health department does not show their date of establishment. Instead, it shows the date of renewal of the registration. As a result, it is difficult to have an idea of the growth of private nursing homes over the years. There is also absence of crucial information on a large number of establishments.

The West Bengal Clinical Establishment Act of 1950 was an Act to introduce the system of registration and licencing in respect of clinical establishment. The Statements and Objectives of the act were available in the Proceedings of the meetings of the West Bengal Legislative Assembly held on 29th September 1950 and the Act came into force in 15th February 1952. It has clarified 'clinical establishment' as any nursing home, physical therapy establishment, clinical laboratory, hospital, dispensary (with bed) medical camp, medical clinic, medical institution of analogous establishment, by whatever name called. According to this Act, 'maternity home' means where women are usually (received or accomodated or both) for the purpose of confinement and ante natal and post natal care in connection with child birth. While 'nursing home'was an establishment where persons suffering from illness, injury or infirmity whether of body or mind are usually for the purpose of nursing and treatment and includes maternity home. No person can keep or carry a medical establishment without being registered in respect of a license granted therefore. West Bengal Clinical establishment Act 1950 has clarified different clauses regarding the application for getting registered under this Act. It has also pointed out the rules about the cancellation of the registration and licence of the 'clinical establishments'.

There is no doubt though that the private healthcare sector in Kolkata is huge, varied, complex and heterogeneous in character. Any uniform or singular pattern of growth cannot be identified. Over the years this sector has expanded, diversified and became one of the significant healthcare providers in the city vis a vis the state.

However, the classification of hospitals on the basis of ownership pattern in *Health on the March* does speak of a private sector. But this 'private sector' does not represent the nursing homes that grew up in the decades after Independence. On the other hand, according to the 1962 issue of the *Health on the March*, we come across two categories of private hospitals:

(a) Private aided
(b) Private non-aided

In 1962, the number of hospitals and hospital beds under 'private aided category' were 23 and 3,146 respectively, while the corresponding figures under the private non-aided category were only 6 and 290. In 1963, the 'private aided' category had been replaced by 'state-aided' hospitals and the number of such hospitals had been slightly reduced to 22 and the number of beds to 3,047. From 1972, the 'private aided' category generally came to signify philanthropic organizations (including missionary efforts). With some alteration of the basis of calculating the number of hospitals and hospital beds, again from 1979, there had been the re-appearance of the 'private aided' category. However, the category 'private non-aided' continued to remain unclear. But it is beyond doubt that neither the 'private aided' nor the 'private non-aided' category represented the *nursing homes of Calcutta.*

Not a single government document makes any reference to the existence of nursing homes in the city of Calcutta in the decades immediately following Independence.

However, *Swasthya Dwipika*, in its editorial section of December 1967 issue, described out the healthcare infrastructure in Calcutta and devoted just a single sentence mentioning that Calcutta had 50/60 private nursing homes. Discussions with physicians who were active during the 1960s indicate that the above estimate is possibly an exaggeration and the actual number would not have been more than 40.

Sections of the medical establishment in the 1950s were not comfortable with the fast growth of the nursing homes in the city. This is revealed in the editorial of Journal of Indian Medical Associations (JIMA) in its May 1952 issue, which also recorded that Calcutta had witnessed the cropping up of a large number of 'bath and massage clinics'.

It has been described in the editorial section of JIMA in its May 1952 issue that in the post-Independence period nursing homes started mushrooming in a limited way. Of late, in the city of Calcutta large numbers of bath and massage clinics have cropped up whose main objective appears to be to dupe the unsophisticated and earn a living out of him. Most of these establishments are run in a most clandestine fashion and there have been several raids by the local police to put a stop to this growing menace. But the existing law was found to be insufficient to cope with the situation.

The editorial section of 1952 issue of JIMA also reflected that while we agree that the so-called massage and bath clinics were doing more harm to the society than good and that preventive measures and definite control over these establishments were indispensably necessary, we do feel that these clinical laboratories and treatment centres run by doctors should be exempted from the operation of the Clinical Establishments Act recently introduced in this province and urge upon the Government to keep such establishments outside the scope of this Act.

Initially, the patients seemed to be somewhat uncomfortable with private medical establishments and did not have any clear idea about these. Private nursing homes were not accepted wholeheartedly. This sector was confined to an entirely different sphere or a space from which the common people was debarred. Its service was meant for a particular section that had the capacity to afford cleaner environment, more privacy and personalized attention, different from that available in the overcrowded and unsanitzed public hospitals.

It needs to be stressed here that the growth and development of the private healthcare sector, particularly from late 1940s to the mid-1980s, may not be associated with:

(a) Decline of public hospitals,
(b) Initiatives on behalf of the government to invite private capital in healthcare,
(c) Impact of the forces of globalization, converting healthcare to a purchasable commodity, or
(d) A public-private partnership project

This scenario was to change radically from 1990's when health care acquired industrial proportion

According to health activist Amal Bose, the causes for the mushrooming of small nursing homes in Calcutta are many. The decade of 1947-1957 was a period of transition when the British model was predominant in healthcare structure. Colonial hangover was present in almost all aspects of life. He recollects that during this phase, in the northern parts of Calcutta a few nursing homes came up having the infrastructure of maternity homes. These were old fashioned nursing homes where the Anglo-Indian community took admissions for treatment. Sometimes they were founded by the missionaries. Some nursing homes were also established by young doctors who were trained abroad. These doctors after their return to India set up nursing homes on the model of the British healthcare institutes. In those days, the doctors were mostly appointed in public hospitals, but simultaneously they could also practice privately and set up nursing homes under their own supervision to expand their practice.

Between 1957 and 1967, there was large scale urbanization and industrialization in Calcutta and its peripheral areas. This led to the increasing population inflow into the city. Both the processes of urbanization and industrialization brought about different kinds of diseases. The public hospitals were already saturated with their patients and the need for more healthcare organizations in this period gave rise to the nursing homes.

According to historian Ranajit Sen, during the 1940s, '50s and '60s, people did not go to private healthcare centres. So, there was no effective demand for the establishment of nursing homes. Till then, the R.G. Kar Hospital, Calcutta Medical College and P.G. Hospital served the population of the city at large. However, the Nilratan Sirkar Medical College and National Medical College were not so popular. These mainly served the east Calcutta population. The Sealdah railway station was crowded by the refugees and middle-class

Bengali patients. Nilratan Sirkar Medical College generally served the patients from north suburban areas and the National Medical College was utilized by the patients of south suburban areas. The Park Circus railway station acted as a communication halt for the south suburban masses. As a result, people from these areas never went to P.G. or R.G. Kar hospital for treatment. Prof. Sen also mentions that in the latter part of the 1940s, there was the Lake Camp Hospital. It mainly served the American soldiers and the well-off sections of the south Kolkata (Rashbehari Avenue, Chetla and New Alipore) population. Doctors of Lake Camp Hospital also practised in National Medical College, P.G. Hospital and Calcutta Medical College. As a result there was no dearth of doctors in the public sector. He recollects that in 1959, his father Pabitra Sen (a retired meteorologist) was suffering from a perforated ulcer. This critical case was treated in P.G. Hospital where a medical board was set up under Dr Lalit Bannerjii and Dr Anjali Chatterjii. It is noteworthy that the latter, a woman physician, had been appointed on the board. Prof. Sen comments that even in late 1950s and early 1960s, the government hospitals had the best of doctors and medical facilities for treating complicated cases.

Nusing Homes which were interviewd in the course undertaking the research are listed in a chronological order.

Nursing Homes established in the late 1940s and 1950s

- Mother's Home (Exact date not Known,early years of 1940's)
- East End Nursing Home Pvt. Ltd (1949)
- North Calcutta Nursing Home (1950)
- Citizen's Nursing Home Pvt. Ltd (1952)
- East End Nursing Home (1959)
- Woodlands Medical Centre (1944)

Nursing Homes established in the 1960s

- Southern Nursing Home (1962)
- Calcutta Maternity and Nursing Home (1963)
- Northland Nursing Home (1964)
- Park Site Nursing Home (1968)
- Eveland Nursing Home & Infertility Clinic (1969)
- Dr B.N. Bose Memorial Clinic, Apollo Nursing Home (1969)
- Belle Vue Clinic (1969)

Nursing Homes established in the 1970s

- Lion's Orthopaedic Hospital & Research Centre (1970)
- Sri Aurobindo Seva Kendra (SASK) (1971)
- United Nursing Home (early years of 1970's, exact date is not known)

- St Mary's Nursing Home Pvt. Ltd (1974)
- Repose Clinic & Research Centre Pvt. Ltd (1975)
- Bright Nursing Home (1975)
- Lake View Nursing Home (1975)
- Dreamland Nursing Home (1976)

Nursing Homes established in the 1980s

- Prince Nursing Home (1982/83)
- Good Hope Nursing Home (Early years of 1980's, exact date not known)
- Swiss Park Nursing Home (1984)
- South Kolkata Clinic (1984)
- Udayan Nursing Home & Investigation Complex (1984)
- Orchid Nursing Home (1985)
- Dr Mina Mazumdar Seba Mandir Pvt. Ltd (1988)

Post Reform Establishments: Nursing Homes established in the 1990s

- Rameswara Nursing Home (1991)
- Peerless Hospital and B.K. Roy Research Centre (1993)
- Care Hospital (1993/94)
- Microlap (1996)
- Zenith Point (1996)
- Paramount Nursing Home Pvt. Ltd (1996)
- Shee Medical Centre (1996)
- Advanced Medicare & Research Institute (AMRI) (1996)
- Cure Centre Nursing Home (1998)
- Five Point Micro Surgery Centre (1998)

Interviews with some of the senior physicians reveal that the nursing homes were very few in number in the next two decades following Independence. The small nursing homes were mostly maternity clinics undertaking delivery cases. These nursing homes were generally established by an individual doctor with some specialization. A doctor under his or her own supervision established a nursing home in one's own house or in a rental house to provide 'service' to the community at large. The doctor-entrepreneur was often also attached with a government hospital. Sometimes the nursing homes were set up in partnership by two or more doctors. Unlike the present day, corporate bodies and private limited companies were seldom present as investors in healthcare. Non-medical persons rarely invested in the sector. Generally speaking, most of the nursing homes were very small, having ten to 15 beds. The services or facilities provided were also very limited.

Minor surgeries in gynaecology, general surgeries of the gall bladder, appendix and hernia, as well as ophthalmologic surgeries were undertaken. Actually the infrastructure in these nursing homes was generally limited and they could never offer major surgical services. Before the establishment of private hospitals (with the notable exception of Woodlands and Belle Vue), people generally flocked to government hospitals for major surgeries and complicated cases.

The nursing homes established in the 1940s and 1950s are now in a decaying state. The phenomena of individual doctors acting as entrepreneurs setting up nursing homes and the latter being mainly maternity centres continued in the 1960s. However, this period also witnessed the mushrooming of small nursing homes undertaking only gynaecological and obstetric cases.

Only a few of the early institutions like the Northland Nursing Home (initially a maternity home later transformed into a general nursing home) have been able to acclimatize themselves to cope with the changes in the private healthcare sector. They have degenerated for various reasons, mainly:

- Financial constraints
- Lack of adequate infrastructure required for upgradation
- The subsequent generation's lack of interest in medical profession

Though the Northland Nursing Home has upgraded itself by introducing ICCU/ITUs, the inflow of patients has reduced to a large extent. The 12-bedded Southern Nursing Home dealing with gynaecological cases is also under severe constraint. However, the Relief Health Care and Research Private Limited, a company investing in healthcare, has taken over the nursing home and revived it from the crisis. Infusion of capital has infused new life into a degenerating organization. Park Site Nursing Home – a maternity home initially, later upgraded to a general nursing home – on the other hand, though in a decaying state, is still serving the community. The case of Eveland Nursing Home is also the same. Even the upgrading of services failed to control its decline. The rapid emergence of corporate hospitals in the peripheral areas brought about a setback for Eveland. The Apollo Nursing Home has revived from its period of crisis, after a trust was formed to look after its financial part. The case of Belle Vue is an exception. Going against the general trend of private healthcare in the 1960s being identified with small nursing homes, it attracted the business magnates and the affluent sections of the society.

Established in the 1970s, Lake View Nursing Home, St. Mary's, Bright Nursing Home and United Nursing Home have suffered a decline. But on the other hand, SASK, Dreamland and Repose Nursing Home are in a much better condition because they did not face financial pressure. However, in case of SASK, the initial funding was provided by a private company and later the land for further expansion was given by the Calcutta Municipal Corporation. SASK has transformed into a multispecialty hospital from a small nursing home since it appropriately adapted itself to compete with the growing market of corporate healthcare

service. Dreamland and Repose are running successfully since they have been able to modify themselves and expand their services with the rising demand.

The entry of non-medical personnel in healthcare for providing capital began slowly from late 1970s. The nursing homes which had started their journey in this decade tried to upgrade themselves with the advent of the corporate hospitals in Calcutta. As a result, they have not suffered decay.

From late1980s onwards, the scenario started changing. The percentage of medical personnel investing in healthcare exhibited a sharp decline. Except Udayan, Orchid and Good Hope, the nursing homes of this period reviewed above were either a joint venture of a doctor and an entrepreneur, or fully financed by non-medical persons. These nursing homes are also in a poor condition because they could not provide the corporate healthcare culture desired by most of the neo–elites of the globalized metropolis. In course of time it was also observed that the joint venture by a doctor and an entrepreneur could no longer bring about profit in the private healthcare institutions (e.g., Dr Mina Majumdar, South Calcutta Clinic and Prince Nursing Home). Though Good Hope is founded and managed by a doctor, it has upgraded its services and is running successfully. But other nursing homes of the 1980s are in a decaying state with the entry of big business houses, regional business groups and corporate capital.

This trend finally gathered momentum in the 1990s when AMRI, Peerless, etc., emerged in the scenario of private healthcare sector. Before that, a few big business houses had invested in healthcare in the 1980s, like in the case of BM Birla, Kothari and CMRI. But their presence was not dominant and they were only utilized by a particular section of the city people. Interestingly, in the nursing homes of the 1990s – Paramount, Cure Centre and Rameswara – investments were made by non-medical persons. There were decorators, contractors and businessmen among them, who had no connection with the healthcare sector. These nursing homes are running successfully and are competing with the private hospitals of the city. But presently the entire private healthcare sector, to a large extent, is in the hands of corporate capital.

However, in the 1990s, some small nursing homes were still coming up, such as Shee Medical Centre, Microlap, Zenith Point and Five Point Nursing Home. They are still functioning successfully in a period when the trend of establishing small nursing homes by an individual doctor has almost subsided. The question is whether these nursing homes coming up in the era of corporate healthcare culture will be able to survive in the long run. Will they have the same fate of the nursing homes that came up in the decades of the 1950s, ’60s and ’70s?

The entry of business groups in healthcare has undoubtedly transformed it into a profit-making industry where the place for socially committed doctors hardly exists. As a result, these nursing homes suffer a setback and are somewhat ‘displaced’ from their previous positions. A group of medical professionals cannot provide the amount of capital a business house can invest. Thus, the smaller nursing homes have failed to provide the expected

services demanded by the neo-elite of globalized Kolkata. The insurance and cashless facilities have definitely increased the access to big hospitals for a particular section but this, on the other hand, totally devastated the small infra-structure of the nursing homes. So, in order to cope with these facilities, the smaller nursing homes are under severe financial crisis and sometimes on the verge of collapse.

Secondly, the doctors who had invested in healthcare in the 1960s and '70s are no more active and due to lack of funds, they have failed to improve the infrastructure of their nursing homes. Owing to the absence of modern equipment, these nursing homes could not attract young doctors who were equipped in state-of-the-art technologies. Nevertheless, in course of time, affordability has increased and people have become more health conscious. Status consciousness and love for comfort also played a crucial role behind their preference towards big private hospitals, which are highly sophisticated, well decorated, and more like 5-star hotels than healthcare institutes. As we have noted, the small nursing homes were mainly maternity homes, which in no way could provide multiple services under one roof.

A major shift has taken place as far as the utilization pattern is concerned. Patients who earlier went to public hospitals are now trying their best to get treated in private charitable (non-profit) hospitals like the Ramkrishna Mission Seva Pratishthan. The clientele of these charitable institutions are shifted towards small nursing homes, which were once utilized by the upwardly mobile sections of the society. The affluent social classes have moved out of these small nursing homes and are shifted towards big private hospitals. Cashless facilities have undoubtedly hastened this process of migration.

Conclusion

Presently, small and relatively inexpensive nursing homes cater to rural people who are able to afford a minimum level of private healthcare. As the public healthcare infrastructure has totally degenerated in the rural areas, rural people tend to flock to the city. The utterly poor make a beeline to the city's public hospitals, while those who may afford somewhat more try their luck in the small nursing homes. To them, getting admitted in a private nursing home in the city is also a mark of social status. Moreover, the urban population in the lower economic strata, having medical insurance (Mediclaim) of less than Rs 50,000, try these nursing homes, for the 'big' private hospitals are simply beyond their reach. Along with the increasing health awareness in almost all segments of the society, people have also come to believe that

- Public hospitals are no longer a better place for treatment
- Quality treatment can be available only in the private nursing homes at a much higher price

The small, once popular nursing homes which survived are now catering to those who are not in a position to go to corporate hospitals, but would not go to public hospitals either.

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Preparation of a bibliography on and by Pandit Iswar Chandra Vidyasagar: an informetric analysis

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Abstract:- The contribution of Pandit Iswar Chandra Vidyasagar in the society of earlier Bengal is noteworthy. He actually reformed the then society to a large extent in different aspects such as education, social welfare etc. Last year i.e. 2019, the 200 years of birth anniversary of Vidyasagar is celebrated throughout the state West Bengal. At this glorious moment it is an attempt to prepare a bibliography to pay homage him. Through this paper the total creation of and by Vidyasagar is depicted here and different aspects are also described here informetrically as far as possible. The whole bibliography is prepared following the APA style format. The total bibliography is divided into two main parts. Each of the parts is also sub divided into different sub divisions following the literature review method. The informetrical analysis involve period- frequency distribution; author wise distribution.

Keywords *Renaissance, Social Reformer, Women education*

Introduction

India is the evergreen galaxy of great men and heroes. At different times, they come and win our heart by their works and activities. Pandit Iswar Chandra Vidyasagar was one of them. He was born on 26th September in 1820 in the village Birsingha of the undivided Medinipur district of the state West Bengal. His parents were Late Thakurdas Bandyopadhyay and Bhagabati Devi. The actual name of Pandit Vidyasagar was Iswar Chandra Bandyopadhyay. He was awarded with the honor of Vidyasagar at the end of the study in the Sanskrit College, Kolkata.

The 19th century is regarded as the period of renaissance of Bengal. This period is divided mainly into three phases:

The first phase was from 1815-1832(period of Raja Ram Mohan Roy); period of Young Bengal (1833-1841) and the period of “Tattobodhini” (1841-1859).

The second phase was the 2nd half of the 19th century and the two decades of the 20th century. These period was from Michael Madhusudan Dutta to Bankim Chandra Chattopadhyay. Another part was from Rabindranath Tagore to Nationalist Movement (1904-1914).

Pandit Vidyasagar (1820-1891) appeared in the junction of these two phases of the renaissance period during 19th century. The working life of Vidyasagar ranged from 1846 to 1875. It was approximately of 30 years.

Pandit Vidyasagar was a versatile genius in his contemporary period. The multifaceted activities of Pandit Vidyasagar made him ever remembered by the Bangalese. He was a true social reformer. His tireless efforts for the empowerment of women in respect of education was always praiseworthy. He tried his best to establish a position of the women in the society. He was a pioneer to influence the then government to introduce widow marriage system in the society that impacted the then society to a large extent. Not only this but his sympathetic mind towards women lead to another movement to stop the system of polyandry by the "kulin" Brahmins.

He was the first person to introduce the real prose style writing in Bengali language in place of poetry style. He wrote the "Barnaparichay" in 1855 for the study of the children. Undoubtedly, this was a remarkable effort by him. Actually he identified the loop-holes of the then education system under the British-ruled India. He tried to create a scientific education system in the Bengal through which the whole student community will be highly benefitted and will become a lifelong learner in future. He translated many books with an attitude of a social scientist. His contributions of creating the proper terminologies in Bengali language is remarkable. He created many terminologies in Bengali language of so many familiar words such as "Science"; "Mathematics"; "Research"; "Astronomy"; "Physics"; "University"; "Superstition" and so many terms. Really, he was very much interested to culture science in Bengali language. Indeed, Prof. Satyendranath Bose tried a lot to culture science in Bengali language. But due to lack of proper terminologies, study of science was a troublesome during that time. Pandit Vidyasagar started this work by his one's own effort. He wrote to Sir Gordon Young, the then DPI(Director of Public Instruction) in 1855 to introduce science subjects from the school level. He encouraged Akshay Kumar Dutta, Prasanna Kumar Sabadhikari, Joygopal Goswami and Bhuban Chandra chattopadhyay to write science literature in some specific science subjects to spread science education in Bengal.

He reformed the total education system of the Sanskrit College in Kolkata during his time. He had to face a lot of difficulties to introduce a new education culture in the Sanskrit College. The door of Sanskrit College was opened to all students irrespective of caste, creed and sex. Really, the Sanskrit College became a center of learning.

The contribution of Pandit Iswar Chandra Vidyasagar towards the University of Calcutta; Asiatic Society, Kolkata; Fort William College and Bethune School, Kolkata was inevitable. He established so many schools in the districts of Hooghly, Bardhhaman and Medinipur with prior permission from the government.

We celebrated the 200 years of the birth anniversary of Pandit Iswar Chandra Vidyasagar in the year 2019. Many lectures, discussions on Vidyasagar were organized by various academic and non-academic institutions at different places in the state West Bengal to pay homage him.

However, it is an opportunity to commemorate the creation of Vidyasagar and other creations on Vidyasagar by many notable authors.

Methodology:- Actually, the literature review method is being followed here. Through the various sources such as books, periodicals etc. the list of books written by Vidyasagar and on Vidyasagar are collected to prepare a bibliography following the APA style format which is prepared chronologically according to their creation. An informetric analysis is also provided here with different aspects of the bibliography. The scope of this study is limited only on Vidyasagar. This bibliography has two parts. The first one deals with the creation made by Vidyasagar himself. It includes not only the documents created and edited by Vidyasagar but some other types such as creations published in journals, letters of Vidyasagar and some posthumous publications. The another one deals with the documents on Vidyasagar created by others in the form of books as well as articles in some journals. However this is an attempt to cover all such creations regarding Pandit Vidyasagar as far as possible.

Objective:- The very objective of this paper is to help the researchers to study in depth on "Vidyasagar" in future. Now-a-days various types of inter disciplinary researches are going on by the scholars of the various academic departments of various universities. Such an informative research paper may be a great help to them. Not only this, researchers may use this information as a part of their references at the end of their research document to encourage to the academic community for further study.

The Bibliography:

PART I

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Letters of Vidyasagar:-

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Informetric Analysis:

This table 1 is a time-frequency distribution of the creation of Pandit Iswar Chandra Vidyasagar. From the table it is found that maximum number of books (i.e. 20) were published in between 1847 and 1857 because these period was the dark age of the 19th century and was full of superstition. After these period publication frequency of books

is comparatively more or less equal. It is found that the number of books published during the period 1858-1868; 1869-1879 and 1880-1890 were 06, 04 and 05 respectively. It is also found that total number of publications as the editor were 13 among which five(05) were published within 1847-1857 and other two(02), three(03) and three(03) books were published during 1858-1868; 1869-1879 and 1880-1890 respectively. There are total five (05) posthumous publications of Vidyasagar. These are four (04) and one (01) during 1891-1901 and 1902-1912 respectively. Total seven (07) essays were published by Vidyasagar in different journals among which 06 were published after his death and only one (01) was published in 1847-1857. There are two letters that are published in the year 1895 and 1971 respectively which are not reflected in the above table.

Table 1: Period Frequency Distribution of Part I Bibliography

The calculation is done approximately after two digits of the decimal fraction.

Period-Frequency Distribution	Books written by Vidyasagar	Books edited by Vidyasagar	Post humus Publications By Vidyasagar	Essays Published In Journal
1847-1857	20 (57.14 %)	05 (30.76%)	NA	01 (14.28%)
1858-1868	06 (17.14%)	02 (15.38%)	NA	NA
1869-1879	04 (11.42%)	03 (23.07%)	NA	NA
1880-1890	05 (14.28%)	03 (23.07%)	NA	NA
1891-1901	NA	NA	04 (80 %)	03 (42.85%)
1902-1912	NA	NA	01 (20 %)	02 (28.57%)
1913-1923	NA	NA	NA	01

				(14.28 %
TOTAL	35	13	05	07

PART II

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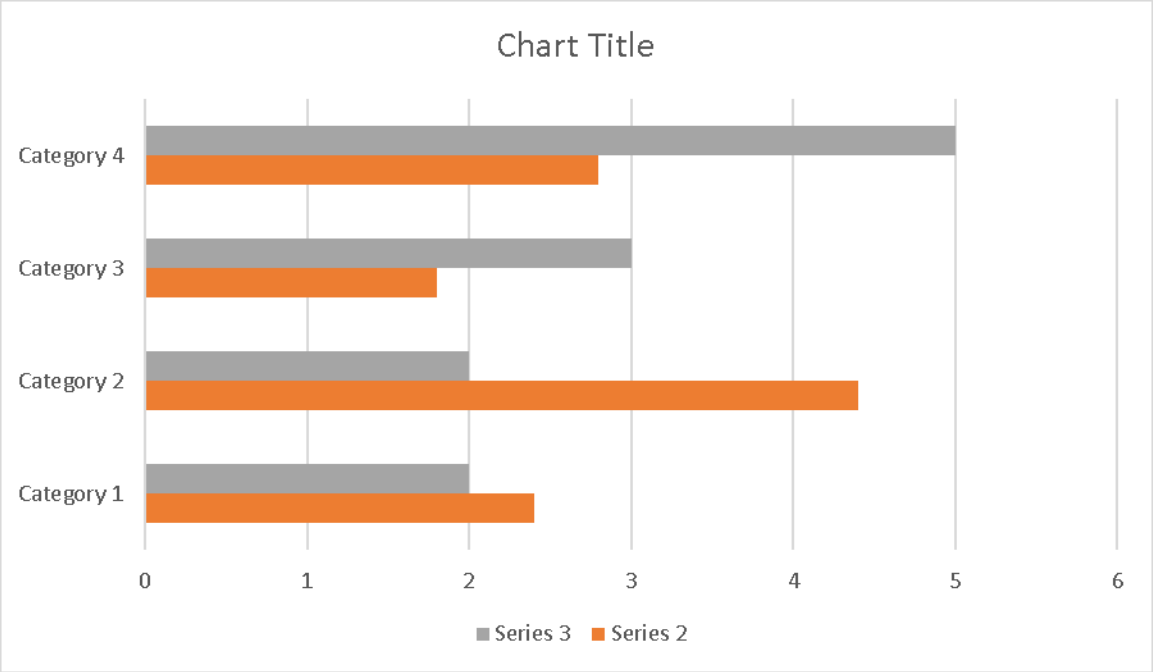
Informetric analysis:-

Table 2 : Period Frequency distribution of Part II Bibliography

Period – Frequency distribution	Books in (Bengali Language)	Journal article In (Bengali Language)	Unknown Authors in (Bengali Language)	Books in (English Language)	Journal article in (English Language)
Before 1850	NA	01	NA	NA	NA
1850-1870	01	NA	NA	01	01
1871-1891	02	NA	NA	03	NA
1892-1912	15	NA	NA	06	NA
1913-1933	16	01	NA	03	NA
1934-1954	21	03	NA	01	NA
1955-1975	58	02	02	04	NA
1976-1996	30	NA	NA	02	NA
1997-2017	22	NA	NA	02	NA
TOTAL	165	07	02	22	01



From this table it is found that maximum number of books (i.e. 58) are published during 1955-1975 in Bengali language. There are only 07 journal articles in Bengali language. The total 22 books are published in English language. Only 01 article is being published in English language.

Table 3 : Authorship distribution

The calculation is done approximately after two digits of the decimal fraction

Author ship Distri- bution	Books in Bengali Language)	Journal article in (Bengali Language)	Unknown Authors in (Bengali Language)	Books in (English Language)	Journal article in (English Language
Single Author	155 (93.93%)	07 (100 %)	06 (85.7%)	21(95.45%)	01 (100%)
Double Authors	06 (3.63%)	NA	01 (13.69%)	01 (4.54%)	NA
More than Double Authors	04 (2.42%)	NA	NA	NA	NA

TOTAL	165 (100%)	07 (100%)	07 (100%)	22(100%)	01 (100%)

This table reveals that maximum books both in Bengali as well as English languages are contributed by the single authors. Only a few books and journal articles are contributed by the double and more than double authors.

From the bibliography it is also found that there are so many publishers from where publications are originated. There are some notable publishers such as Sanskrita Press Depository, Bangiya Sahitya Parisad, Ananda Publishers, Dasgupta, Dey's, University of Calcutta, Asiatic Society, Vidyasagar Research Centre etc. There are so many publications from Bangladesh also. However, it is very difficult to enumerate of all such Publishers individually.

Subjective view of the Bibliography: In this paper the total bibliography has two parts. From the titles of the Part I bibliography the subjects are more or less cleared. Mainly these are confined into grammatical concept of both Sanskrit and Bengali languages. On the other hand, the Part II of this bibliography deals with the various aspects of Vidyasagar such as biographical aspect, Literature aspect, new concept of education ,social reformation point of view and many other related concepts. The form of the most of the documents are confined into essay type publication.

Findings: This article has two parts. One is the part I which gives the detail bibliography by Pandit Iswar Chandra Vidyasagar and the another one is the Part II which is the reflection of the bibliography by the others. It is very interesting to note that the number of the part II bibliography is more than that of the part I. It proves that the research as well as importance of study on Pandit Vidyasagar is still increasing and is also a serious matter of consideration.

Most of the bibliography on Vidyasagar are written in Bengali language followed by the English language. Not only this, but maximum publications are essay type. The journal publications are less than the book publication in both Bengali and English language.

Conclusion: During the 19th century, female education got momentum by the joint efforts of Vidyasagar & Madanmohan Tarkalankar with the active support of Bethune saheb, an Englishman. Pandit Vidyasagar made a bridge in between the classical Sanskrit study and of introduction of Bengali language education. The strong common sense, kindness, strong personality, punctuality etc. made him an ideal person in the contemporary periods. The contributions of women in the freedom fight movement of India became possible due to spread of education among the female. Pandit Vidyasagar played a great role in this achievement. Truly, Vidyasagar was a follower of Raja Rammohan Roy in the 19th century in Bengal. In the year 2019, the celebration of 200 years of birth anniversary of Pandit Iswar Chandra Vidyasagar in different places of West Bengal particularly such as schools, colleges, universities, education department(s) and many other organization(s) in the form of seminars, conferences, invited talks, open forum discussions etc. proved the relevancy of the ideologies,

notable creations and the viewpoints of social reformation of him once again in the 21st century also.

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A Comprehensive Study of Lux Soaps in India: Negotiating Gender and Advertisements

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Abstract: For the last few decades advertising has become a challenging media. Each and everyday the challenge grows bigger. The demand of the society, the demand of both advertisers and consumers and that of common people is in big question now. The challenge so far is felt in the equation of gender as it remains foregrounded within advertisements. Gender, in its curious connotation, is a socially constructed term which is intertwined with the mythical concept of beauty. The advertising industry is aware of it. They sponsor beauty products in large scale. Lux soap, the 'Face of India', is also a part of this campaign. The beauty myth and its place in the corpus of gender can be mapped through the advertisements of Lux in the last 91 years; a study which can reveal only how, with time, the images of Film Stars have changed, questioned and subverted the very core of patriarchy.

Key words: *gender, advertisement, beauty, metrosexuality, own gaze*

Lux soap is a beauty product for the last 91 years in India. Lux soap which was known as 'sunlight flakes' laundry soap earlier, gradually established itself as a domestic brand in the United Kingdom in 1899. In 1900 its present name was rechristened. It was launched in India in 1929. At present, Lux is sold in 100 countries with a turnover of 1 billion Euros alone in 2005.Out of five, every three women use it in their daily lives. As it is a trusted brand in Indian market for the last 91 years featuring almost every female star of the Bollywood industry (Shah Rukh Khan being the exception), the advertisement of Lux can be studied as a document which paved a new horizon of gender.

The discourse of advertisements have a certain meaning and ideology. Meaning, as it is latent within the discourse, is a social mirror. We often identify ourselves with the product we buy. This identification usually leads to a negation between the real and the hyperreal and calls for a postmodern spectrum. The term ideology may seem an outdated practice which "mediates what we know, how we feel, and the way we live" (Williamson vi). Gender is an integral part of such introspection. It simultaneously adds meaning to the macrocosm of advertisemrents. Meaning can be ambiguous and multifarious both. The advertisements of Lux Soap, therefore, prompted me to draw attention not only "to describe sexism in a text, but also to analyze the way that point of view, agency, metaphor or transitivity which are unexpectedly closely related to matters of gender (….)" (Mills 1). In the light of the preceding statement I have contextualized Lux advertisements of 1941 to 2020 in the backdrop of its milieu. For that I have divided them into two parts: from 1941-1980 (Leela

Chitins – Prema Narayan) and 1981-2020(Sridevi- Saifeena) . Four images of Lux Soap have also been added in the last few pages (pp.8-11) to show the major changes that took place.

1941-1980 is the developing phase of Lux advertisements. Featuring Leela Chitins as the first Indian brand ambassador, Lux began its journey in 1941. Its popular slogan was the 'beauty soap of film stars'. Beauty myth is an intrinsic part of our daily life. Women in India would secretly desire to become as beautiful as the film stars. A feeling of guilt arises from the secret ambition of being so. Conflict is also felt elsewhere- to be naïve or to be sensual or to be both? Film stars like Nargis (1940s),Renuka Roy (1940s), Suraiya(1940s), Meena Kumari (1940s), Nirupa Roy (1950s),),Madhubala(1950s), Nanda(1950s), Waheeda Rahman(1960s),Vyjayanthimala(1960s), Mala Sinha(1960s), ,Tanuja(1960s),Sadhna(1960s), Kalpana (1960s),Helen (1960s),Hema Malini (1960s), Saira Banu(1970s), Jayaprada (1970S),Babita(1970s),Sharmila Tagore(1970s),Rekha (1970s), Padmini Kolhapure (1980s),Zeenat Aman (1980s),Poonam Dhillon (1980s),Prema Narayan (1980s) are representative of such dilemma.

Leela Chitins in her 1941 debut has been portrayed as a stereotypical Indian woman. She is secretive, sensual and simple. Her personality glorifies her femininity. It prepares her for the male gaze. Surprisingly, Nargis, Waheeda Rahman and Vaijyanthimala, actresses from two different ages are coded as "teen deviyan". The advertisements claim them as "classic beauties" of the silver screen. Their sacredness is being emphasized through "deviyan". The beauty of Renuka Roy and Nirupa Roy are reflected in the image of their truthfulness and simplicity . Suraiya is the stereotypical Indian woman who impresses others by her simplicity. Simplicity and sensuality are the two precipitating factors which allure common Indian men. But the star value is added to Lux with the enticing and surreal beauty of Madhubala. Its credibility as a beauty soap of stars started with her.

It can be easily inferred from the catchy phrases of Lux soap advertisements that the modifier fair gives a certain weight to existing belief. A fair woman's chance of getting married is better than that of a not-so-fair one. Engaging on this belief Lux promises to give not only a cleaning experience but also a fairer and softer skin. The glory of fair complexion continues with Saira Banu, Sadhna, Jayaprada, Babita and Sharmila Tagore. The coyness of Tanuja and her kind of complexion draws our attention to the upcoming years. The seductive beauty of Helen and the divinely Hema Malini caters to the taste of Indian audience. Contrary to this, Rekha, the controversial black beauty of Indian cinema, breaks the image. She becomes a mouthpiece of "I know how to get and what". By coining this sexual inneundo the advertiser allures Indian women to be coy and seductive both.

Coyness and innocence are binary opposites; as is fair and ugly. But the advertiser makes them grey owing to the continuous demand of the market. Globalization enhanced this process as "After 1985, in an effort to revive the stagnant economy, some measures towards economic liberalization were introduced and there was growth in the economy. GDP reached an average of 5.5% in the 1980s (India Tradepoint, 1995) and per capita income increased by

40%."(Ciochetto 1). In the 1990s the liberalization of the economy continued, some of which was externally imposed: investment expanded from 1994-1995 but it was often erratic. Industry expanded as well though there were also many casualties.

Economic liberalization uplifted the socio-economic construct of the middle and the upper-middle class. The latter part of the 1980s was a witness to the rising of the urban middle clas. 'It rests on the assumption that the shift in the Indian state's economic policy in favour of globalization has accompanied a shift in public discourse as evidenced in the media' (Chowdhuri 1).Therefore, the pre-globalized and the globalized advertisements underwent vast socio-economic as well as political changes. Gender, being an integral part of such change finds a new dimension. The shift was from the ideal homemakers to the 'globe trotting corporates'.

This paradigm shift is also evident in the advertisement of 1981-2020. The shift from Sridevi (1990s) to Saifeena (2020s) is a remarkable change in gender roles. Although Sridevi and Madhuri Dixit strictly adhere to their predecessors, Swarup Sampat and Kajal advance towards a newer definition. They are lustful and tomboy both.

But there was a phenomenal change in the representation of gender in Lux advertisements in the year 2005. As the brand reached its 75th year, it endorsed Shah Rukh Khan being surrounded by four epitomes of beauty-namely Hema Malini, Sridevi, Juhi Chawla and Kareena Kapoor. Shah Rukh Khan earned much controversy revealing the 'raaj' of his beauty. In 2020, Saifeena (Saif Ali Khan and Kareena Kapoor) took the step further. In a moonlit dinner Saif Ali Khan unveils 'chaand sa roshan chehra' of Kareena Kapoor.

I have added four different images of Lux Soap in this paper. The first one is of Leela Chitnis, second Kareena Kapoor having a chocolate bath, third of Shah Rukh Khan and finally of Saifeena (portmanteau of Saif Ali Khan and Kareena).

From all the above mentioned advertisements we cannot but ignore the patriarchal hierarchy that exists within. In some cases when the target audience is the common people, stereotypical advertisements portray women as the feminine, seductive and sensual; precisely, an 'object', a 'commodity'. Whereas just in the opposite case, men are portrayed as 'individuals'. They also seduce but mostly with a woman in the background, satisfying both the 'male' and the 'female gaze'. Leela Chitnis, as her image is portrayed in the advertisement, is the stereotypical Indian woman. She obeys what the society wants; feminine, secretive and simple. She is a star yet a homely woman. Such image has been exploited and manipulated by the advertisers to reach their target consumers. Barthel stated that 'women still control some 80% of the buying power' (7). With the advent of Globalization, the buying power of women has increased. Women are lucrative consumers who do justice to the product. Modern women's buying capacity probably motivates the advertisers to reshape their Lux advertisements. Thus, in the following years, there is a remarkable change in the rhetoric of Lux advertisements. It took a long time to endorse Lux soap as a beauty product not only for fair women but also for not-so-fair one. The shift from

Leela Chitnis to Rekha questions, challenges and subverts the stereotypical concept of Indian women. Patriarchy may find it oppressive, subjugative but Lux paved the way for that.

A question may arise as to whether this soap is meant only for women or not. Most probably to cater to the aesthetic taste for both men and women, Lux, in 2005, introduced Shah Rukh Khan as the metrosexual man. Metrosexual is a portmanteau of metropolitan and heterosexual man, coined in 1994, who enjoys shopping, fashion and similar interests traditionally associated with women. "The metrosexual trend can be seen both as men expressing femininity and as masculinity being defined more broadly. During this time the acceptable male gender role expanded and became more inclusive of divergent expressions of male identity. It no longer stood in stark binary contrast to the feminine, because part of metrosexual masculinity embodied traditional notions of feminine traits" (Anderson 6). It is often assumed that capitalism introduced to this newly defined gender role. A part of their agenda is to spoil the retrosexual man with shopping spree like women- to make them more conscious of their image and identity. Difference is also sought in the manner Shah Rukh Khan is represented. He is surrounded by a galaxy of female stars who help to delineate the secret of his beauty. Interestingly, there could be either female stars or Shah Rukh Khan alone.

Finally we move on to the two contrasting images; one which depicts Kareena Kapoor indulging herself in a chocolate bath and the other in which Kareena Kapoor alongwith her husband Saif Ali Khan savour a moonlit dinner. In the first image it is noted that Kareena Kapoor takes a fresh chocolate bath with Lux which makes her bold, lustful and attractive.

But this image does not last long. In the Lux advertisement of 2020 Kareena Kapoor plays the role of traditional Indian woman who conforms to the hierarchy of patriarchy. She represents the stereotypical Indian woman by being sensuous, loving and beautiful to her husband. Saif Ali Khan compares her beauty to that of a moon- quiet and soothing. She no more questions patriarchy and surrenders to it.

Lux soap advertisements undertook a gendered journey which was multifaceted- from stereotypical role of Indian women to metrosexual men and finally conforming to the traditional Indian men and women both. In this journey it unknowingly gave birth to the metaphor of 'other'. Otherness is found in metrosexual to retrosexual- from satisfying 'male gaze' and 'female gaze' to 'own gaze'.

As Shah Rukh Khan marked the beginning of a new history, it threatens gender bias and poses a question- shall we remain happy with 'male' or 'female gaze' or we shall break the myth and advance towards a new era where our 'own gaze' will be satisfactory and celebrated. The answer is yet to come.

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Agronomic Advancement of Rice: A Review

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Abstract: Rice is the second most important food grain in terms of human nutrition and calorie intake, providing more than one-fifth of the total calories consumed worldwide. India, being the center of origin of rice, is the storehouse of a large number of local varieties and landraces. Our state, West Bengal is known as 'bowl of rice' as it is the staple food and the major cultivated food crop of the state. From a wild aquatic grass, Indian farmers over the centuries selected and cultivated thousands of varieties of rice; no other cultivated crop has been developed to such an extent to fit thousands of ecological niches all over the country. Local indigenous rice varieties have adjusted over long periods to the ecosystems of their regions including climatic variations, thus ensuring at least minimum levels of output even in bad years. The present review work is carried out to discuss different agronomic features, seed phenotyping as well as the germination physiology along with studying the interrelationship between physiochemical & anatomical characters in rice, all in the light of superior yield potential.

Key Words: *Rice, crop, agronomic features, seed phenotyping, photosynthesis.*

Introduction:

Rice is the world's 2nd most important food crop of human consumption (FAOSTAT, 2014) feeding about 2.5 billion people worldwide. The total annual production of milled rice in the world during 2018-2019 was about 501 million metric tons (USDA FAS, 2019). The Green Revolution technology developed at the International Rice Research Institute (IRRI) in the 1960s increased worldwide rice production. It is imperative to increase rice production in different rice-growing ecosystems to feed the increasing world population (Khush 2005).

Rice belonging to the genus *Oryza*, comprises of four species complexes: *O. sativa*, *O. officinalis*, *O. ridleyi* and *O. granulate* (Ricepedia, 2019). The genus contains 24 recognized species including 22 wild species and 2 cultivated ones: *O. sativa* and *O. glaberrima*. The 23 wild species represent the 10 genome types distributed throughout the tropical and subtropical areas of the world. (Sanni et al. 2013). The 10 different genome types are based on chromosome pairing behavior at meiosis in interspecific hybrids and are designated as AA, BB, CC, EE, FF and GG (diploid genomes) and BBCC, CCDD, HHJJ and HHKK (allotetraploid genomes) (Ge et al 1999, Sengupta et al 2009, Sanchez and Wing 2013).

India is the second-largest producer of rice after China (Patel et al 2019) and inhabitants of Gangetic West Bengal depend on rice as their staple food. West Bengal has diverse local germplasms with special characteristics. Local landraces are facing serious threat of extinction due to hybridization and genetic engineering techniques. Although these techniques are beneficial from the commercial point of view, germplasm preservation of the local varieties is needed for their unique beneficial traits. Thus, such varieties need to be characterized systematically. In the present work characterization of rice genotypes based on

morphological and physiochemical parameters, seed protein profiling, germination efficiency, leaf anatomy and its relation to photosynthetic efficiency and molecular marker-assisted polymorphism detection has been emphasized. In West Bengal, rice is cultivated in three season's viz., *Aus* (autumn rice*), Aman* (winter rice*)* and *Boro* (summer rice). Rice cultivation spans diverse agro-climatic regions like irrigated, rain-fed, coastal saline, and flood-prone ecosystems (Rice Knowledge Management Portal). Farmers do not solely rely on yield as the criterion to select a particular rice variety. A variety is also selected based on its ability to fit into a particular cropping system, meet household demand and have practices applicable by the farmers in their land (Samanta and Mallik 2004).

Rice cultivars differ in milling, cooking and textural properties as well as their suitability for different purpose. Genetic traits, environment and cultivation practices including application of fertilizers are responsible for variation in rice quality.

Various strategies to increase the yield potential of rice include conventional hybridization and selection, ideotype breeding, hybrid breeding, exploitation of wild species germplasm, enhancement of photosynthesis, genomic and physiological approaches (Khush 2013). Advances in molecular biology and genomics have opened new avenues to apply innovative approaches to rice breeding.

Agronomic characters

Seed characters:

Seed weight: The rice grain comprise of the hull/husk and the caryopsis. Removal of the hull/husk during initial milling procedures produces brown rice. The rice caryopsis is further composed of pericarp, aleurone layer plus seed coat and nucellus, embryo, and starchy endosperm (Zhou et al 2002). Further abrasive milling removing the outer maternal tissues as byproducts of rice bran and polish, gives the final milled or polished or white rice. Brown rice or the dehusked grain has the lowest protein content and total dietary fibre among the major cereal grains, but the highest content of starch and available carbohydrates (USDA 2016). While the milled rice (white rice) is richest in starch as it is mainly the endosperm portion, the brown rice also contains higher levels of protein content, crude fat, crude ash, phenolics, phytic acids and dietary fibres. Pigments if present, are located in the pericarp (Juliano 2019). Thus the seed weight is the measure of the nutritional components present in the seed/grain, which is further regulated by the grain production factors. The main component of the starch grain being the starch shows differential compositions of the two major forms as the linear chain amylose and the highly branched amylopectin, assembled in a clustered structure formed of granules further being composed of starch molecules laid down in concentric rings. The amylase and amylopectin contents variability in different rice varieties majorly affect their corresponding cooking characteristics, texture, stickiness, water absorption ability & volume expansion, hardness and even the whiteness and gloss of the milled rice (Zhou et al. 2002) further affecting their grain yield and effectiveness in the market from the acceptance and popularity point of view of the market. Among several factors, rice yield depends upon the size and mass of kernels. These factors also determine the commercial value of milled rice based on human perception (Singh et al. 2019).

Seed size: 'Grain size' or seed size is an important and most stable component among the seed characters in determining the 'grain yield', which in turn is correlated with the grain-filling rate (Fujita et al. 1984). 'Grain yield' being the primary economic target or issue is a determining character to choose a particular variety for large scale agricultural crop practice. Thus, apart from the grain-filling time and other environmental conditions including the amount of irrigation water (Guo et al. 2015), which regulate the 'Grain production', grain or seed size attains a major point in focus, somewhat indicating larger size pointing towards more yield. Seed shape also plays a role in differential yield study. It is observed that very naturally large grain facilitates more dry matter accumulation over small grain with time in the grain-filling period (Coronel et al. 1983).

Awn: Different varieties of cultivated rice are characterized by mainly awnless seeds or rarely seeds with short awns lacking barbs. It is being speculated that today's cultivated rice has been domesticated from the wild rice variety, several years ago through different morphological, physiological as well as genetic level changes (Hua et al. 2015), among which, complete loss of awn or if present then in reduced form is a distinct change. Currently, the presence of awn facilitates the process of seed collection, storage and associated human-handled matters.

Aroma: The unique aroma of scented rice grains gets imparted mainly due to the presence of several primary and secondary metabolites which are basically volatile organic compounds (VOCs). In this case, a novel compound named 2-acetyl-1-pyrroline (2AP) has been observed to be the significant factor found as the primary contributor in imparting the unique fragrance in rice. It has been reported that both aromatic and non-aromatic rice varieties possess the characteristic VOC '2AP' but the only difference is the concentration of the potential compound between them (Wani et al. 2016). In scented rice varieties, aroma-causing volatile compounds are synthesized in aerial plant parts and finally get deposited in the mature grains. Also, the availability of primary and secondary metabolites including these VOC's is highly variable across the different developmental stages of the corresponding rice plant (Hinge et al 2016). This aroma of the rice grain acts as a crucial factor in imposing a premium market value and also gaining consumers' preference (Wani et al. 2016).

Panicle characters:

The different panicle characters are mainly the 'yield contributing' factors that ultimately depend on production efficiency. It has been observed experimentally that lower grain yield occurs due to a lower number of spikelets per panicle, a lower percentage of filled grains (Sun Guo-Xin et al 2015), thus denoting that superior panicle characters correspond to superior yield.

The terminologies related to rice plant morphology are represented in Fig 1.

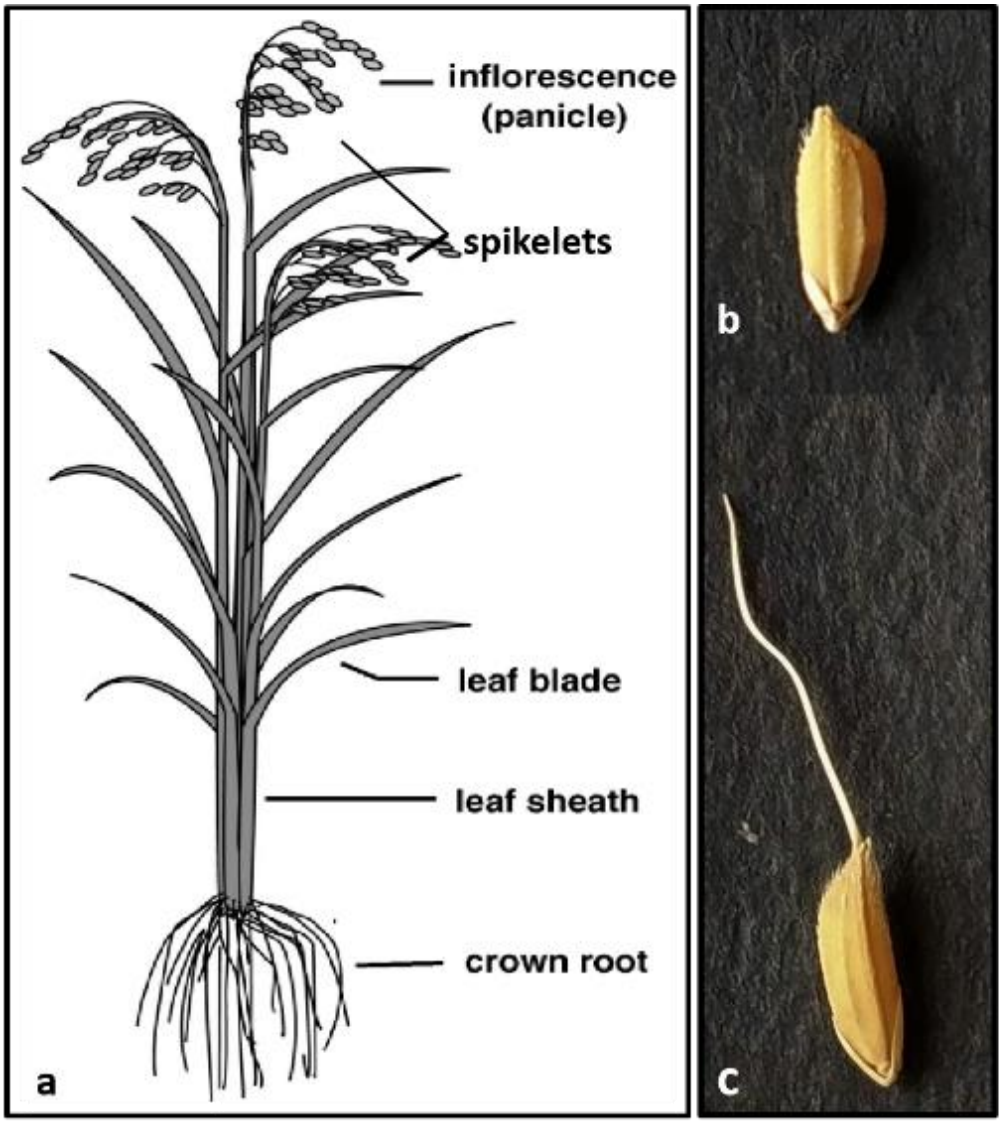

Fig 1. **a**: A mature rice plant. **b**: A seed without awn. **c**: A seed with awn (adapted from Itoh *et al* 2005)

Study of seed phenotype

Phenomics is the systematic study of phenotypes with the help of automatic modern multifunctional high-throughput phenotyping tools and techniques. One such major technique is the image-based plant phenotyping method involving several image analysis methods to measure and quantify different plant phenotypic traits. Software have been designed to perform specific tasks related to this task managing the analysis of the phenotypic traits of interest. This image-based phenotyping tools provide a vast ease to the huge and time-consuming task of manual image analysis as well as quantification related to the phenotypic plant traits (Zhao et al 2019). Man-machine coordination also reduces the chances of errors while measuring the data. The present modern age of plant bioscience is thus progressing towards more and more precision and advancement day by day.

Comparison between wild species and cultivated ones revealed similarity in seed morphology (Kasem et al 2010) and endosperm morphology (Shapter et al 2008). Chemutai et al (2016)

classified African rice genotypes based on alkali digestion (indicating variation in amylopectin chain length) and gel consistency assay. Difference in gel consistency of cooked rice indicated differential expression of waxy (Wx) gene. Screening for better cooking and edible traits such as linear kernel elongation, water absorption and volume expansion as well as fuel consumption can be selected based on the above assays. Four exotic rice varieties of Afghanistan showed wide variations with respect to plant growth (plant length, tiller number, leaf number, days to heading, and maturity); grain yield and panicle number per hill, spikelet number per panicle; physicochemical properties like protein, amylose, and lipid contents; antioxidant activities; and internal structure of endosperm. Such studies help in sustainable selection and cultivation of preferable varieties (Kakar et al 2019). Pre-harvest and post-harvest ageing affect the physical qualities of rice like cooking, pasting and thermal properties. Post cooking, aged rice was found to be harder, fluffier and less sticky than fresh rice, being mainly affected by duration and temperature during storage (Keawpeng et al 2015). Grain traits are highly associated with rice production and serve as key factors for grain yield and its market value (Yao et al 2016). Abiotic and biotic stress resistance and other traits have been successfully introduced from wild species into cultivated rice, resulting in improved cultivated varieties (Vaughan 1994). However, wild species have traits beneficial for use with intrinsically similar starches and functionalities to cultivated rice. Analysis of the morphological and edible properties of the indigenous cultivar seed grain is required for commercial use. Physicochemical tests based on rice chemical composition, cooking quality, gelatinization temperature and physical properties of cooked rice are used to analyze rice germplasm diversity. Rice eating and cooking quality (ECQ) is mainly determined by amylose content, gelatinization temperature and gel consistency (ZhiXi et al 2010).

Germination efficiency

Seed germination is an early and crucial stage in plant life cycle, referring to the complex physiological and biochemical process starting from the uptake of water by the dry seeds and ending with the successful radicle protrusion (Bewly 1997), involving a series of co-ordinated signal transduction and gene expression regulation, the actual sequence of which is still unknown. A number of exogenous and endogenous factors act in the regulation of the germination procedure and it's efficiency including water, as one of the most crucial decisive factors, temperature, light, circadian rhythm, and phytohormones i.e. GA (Gibberellic acid) and ABA (Abscisic acid) being the two main phytohormones that antagonistically regulate seed germination by controlling GA and ABA-responsive functional proteins creating a protein mobilization during the germination process. Thus seed germination efficiency can precisely determine its ultimate seedling growth and even crop yield in the broader prospect (Yang 2013).

Seed vigour or the potential of a seed to germinate rapidly and uniformly under a wide range of field conditions is an essential requirement for agricultural production (Finch-savage et al 2015). Other measures of vigorous varieties include seed filling rate, germination percentage and uniform seedling growth. These features are beneficial from the commercial point of view of the productivity of a variety. High seed filling rate and short seed filling duration

caused a significant decrease in the total starch and amylose contents and an increase in the amylopectin content (Wang et al 2020). The role of physio-morphological, biochemical and molecular marker analysis in rapid germination of seeds and seedling biomass has been reviewed in detail by Mahender et al (2015). Major QTLs for seedling vigour index of direct seeded rice along with abiotic stress tolerance capacity contribute to screening efficiency of rice varieties.

Protein profile

Rice has a relatively low protein (7% to 10% DW) compared with other cereals (Khush 1997). Storage proteins are accumulated during seed development and are coded by multi gene families. Rice storage proteins are of four types: albumins, globulins, prolamin, and glutelin (Fig 2). The nature of bands on SDS page is genotype specific and can serve as reliable marker due to their polymorphic nature and normally being unaffected by environmental conditions during the seed development and maturation (Sadia et al 2009; Mehtre and Dahat 2001). Protein bands detected in specific rice varieties could serve as biochemical markers. Genetic diversity of storage proteins can be thus beneficial in pedigree analysis and nutritional quality improvement. Endosperm is the reservoir of starch and proteins are accumulated during seed development. Several transcription factors are involved in the expression of the genes for storage substances. The rice *flo2* mutation resulted in reduced grain size and starch quality. Map-based cloning identified *FLOURY ENDOSPERM2* (*FLO2*), a member of a novel gene family conserved in plants, as the gene responsible for the rice *flo2* mutation. *FLO2* was abundantly expressed in developing seeds coincident with the production of storage starch and protein, as well as in leaves, while abundant expression of its homologs was observed only in leaves. The *flo2* mutation decreased the expression of genes involved in the production of storage starch and storage proteins in the endosperm. Differences between cultivars in their responsiveness of *FLO2* expression during high-temperature stress indicated that *FLO2* may be involved in heat tolerance during seed development. Overexpression of *FLO2* enlarged the size of grains significantly. These results suggest that *FLO2* plays a pivotal regulatory role in rice grain size and starch quality by affecting storage substance accumulation in the endosperm (She et al 2010).

Studies have been carried out extensively on rice proteome. Overall, 480 reproducible protein spots were detected by two-dimensional electrophoresis on pH 4-7 gels and 302 proteins were identified by MALDI-TOF MS and database searches. Together, these proteins represented 252 gene products and were classified into 12 functional categories, most of which were involved in metabolic pathways. Database searches combined with hydropathy plots and gene ontology analysis showed that most rice seed proteins were hydrophilic and were related to binding, catalytic, cellular or metabolic processes. (Yang et al 2013).

He et al (2013) carried out protein profiling in the germinating rice seeds. In total, 673 proteins were identified and could be sorted into 14 functional groups. The largest group was metabolism related. The metabolic proteins were integrated into different metabolic pathways to show the style of reserves mobilization and precursor preparation during the germination.

Analysis of the regulatory proteins indicated that regulation of redox homeostasis and gene expression also play important roles for rice seed germination.

Interrelationship between the physiochemical & anatomical characters

Genomic DNA isolation and molecular phylogenetic study:

Completion of the rice genome sequence (Yu et al 2002) and advances in transcriptomics research has made it possible to identify and map a number of genes through linkage to DNA markers precisely. Genes for resistance to pathogenic infection and abiotic stress are commonly linked to markers. Molecular marker-aided selection (MAS) combined with conventional breeding approaches help to identify the individual genotypes associated with grain quality, abiotic and biotic stress tolerance features, which can be used to improve the breeding efficiency. ZhiXi et al 2009 developed 51 gene-tagged molecular markers according to sequence variations in 18 starch synthesis-related genes from 16 typical rice cultivars. This genotypic differentiation of germplasm provides the basis for selection and breeding of new elite rice varieties. Artificial selection is normally based on desired phenotypic traits and novel multiple alleles might exist in wild rice species. Correlation in agronomic characteristics, aroma and SSR markers helped in selection of favorable hybrid varieties which can be utilized in breeding programmes (Kibria et al 2008). Depending upon quantification of genetic diversion among aromatic accessions based on SSR markers Alijumaili et al (2017) identified and selected accessions for varietal development in breeding programs. Construction of dendrogram to identify genetic similarities among these genotypes showed that accessions from the same regions cluster mostly together implying a correlation between molecular groupings and geographical source. Combinatorial analysis based on seedling morphology in response to salinity stress and SSR markers linked with salt tolerance quantitative trait loci helped to detect the true salt tolerant genotypes (Ali et al 2014). The authors successfully identified three SSR markers for salt resistance screening. The role of molecular markers and marker-assisted selection for polygenic traits, abiotic and biotic stress resistance, agronomic traits and grain quality has been reviewed in details by Jena et al (2008).

Random Amplified Polymorphic DNA (RAPD), a PCR based marker analysis is performed routinely to assess the genetic diversity and genetic similarity quotient among different cultivars, using random decamer primers. Conservation of genetic variability paves way for germplasm preservation as well as selection of genetically diverse cultivars for crop improvement programs. Dendrogram analysis based on similarity coefficient helps to group cultivars into clusters and is indicative of intraspecific or intraspecific hybridization. Such an approach has been investigated by several authors (Rahman et al 20016, Pervaiz et al 2010, Jena et al 2010, Rajani et al 2013, Abdulrazzak 2014, Rubel et al 2014). Single and multigrain Aman varieties provided a platform to identify improved varieties and grain relatedness at DNA level (Mitra et al 2017). 14 improved varieties and 27 landraces of rice varieties cultivated by Indian farmers subjected to morphological and SSR marker analysis

revealed the possible linkage or pleiotropic effects of the genomic regions associated with certain grain quality traits (Pachauri et al 2013).

Banerjee et al 2010 pointed out that biochemical (isozyme and total soluble protein) and molecular (RAPD) polymorphism profile among 18 traditional and improved rice varieties can substantiate morphological data to establish distinctiveness among the varieties. Zhang et al 2011 correlated population structure and genetic diversity and noted that gene diversity and across the genome of two populations might help to identify candidate genes for the traits under domestication and artificial selection.

Photosynthetic efficiency:

Enhanced photosynthesis by conventional breeding

Leaf is intricately linked to plant yield as it is the site of transpiration and photosynthesis. In rice plant, the flag leaf below the panicle provides photosynthetic product to the panicle (Wang and Li 2005). Crops with an enhanced photosynthetic mechanism would better utilize the solar radiation that can be translated into yield. This subsequently will help in producing more grain yield, reduce water loss and increase nitrogen use efficiency, especially in hot and dry environments.

Analysing rates of individual leaf photosynthesis (*P*n) is necessary for yield increase. The *P*n values of the two backcrossed inbred lines at an ambient CO_2 concentration of 370 μmol mol^{-1} as well as at a saturating concentration of CO_2 were 20–50% higher than those of the parental *indica* varieties. In comparison to the parent, the inbred lines did not show a higher amount or activity of Rubisco under similar leaf nitrogen contents. However higher mesophyll conductance with respect to CO_2 flux was attributed to better development and higher density of mesophyll cells. These lines had higher electron transport and growth rates. Since atmospheric CO_2 is expected to increase in the future; it is possible to obtain significantly higher *P*n under enhanced as well as normal atmospheric CO_2 levels (Adachi et al 2014). He et al 2016 reported that photosynthetic rate (in the flag leaf and 13^{th} leaf) of two lines obtained by *indica* x *japonica* backcross was 20% higher than the high yielding *indica* parent. Although there was no consistent difference in stomatal conductance and Rubisco content, increase in mesophyll cell number and conductance was related to the higher photosynthetic efficiency.

Enhanced photosynthesis by conversion of C_3 to C_4 :

A striking approach towards increasing the agricultural productivity of rice is to convert the C_3 photosynthetic mechanism to C_4. The efficiency of C_4 photosynthesis has generated a great interest and some serious efforts in engineering a functional C_4 photosynthetic pathway into C_3 crop species i.e., rice aiding in higher rates of photosynthesis in the experimental rice plants. As the evolution of C_4 plants took place from C_3 ones over a period of 30 million years, it is expected that key genes and gene regulatory pathways were inherited from the C_3 plants. Hence several techniques including genome-wide deep-sequencing, gene discovery and editing have been applied towards engineering C_4 rice plants.

In C_3 plants, photosynthetic reactions occur primarily within the mesophyll cells where ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco) fixes CO_2 in the Calvin cycle. In hot dry environments, however, this fixation reaction is competitively inhibited by O_2, leading to the energetically wasteful process of photorespiration. C_4 plants evolved to overcome this inefficiency, through the development of mechanisms that concentrate CO_2 around Rubisco. In the C_4 photosynthesis, β-Carbonic Anhydrase (CA), present in a localized way in the cytosol of the leaf mesophyll cells, is responsible for the formation of HCO_3^- from CO_2, which in turn acts as the substrate for the O_2-insensitive phosphoenolpyruvate (PEP) carboxylase in the initial step of C4 photosynthetic pathway where thus through this CO_2 fixation, a four-carbon first stable compound Oxaloacetic acid (OAA) is formed. CO_2 is thus first fixed into OAA by the (PEP) carboxylase. The four-carbon compound is then shuttled to a separate compartment (either within the same cell or in another cell) where it is decarboxylated to release CO_2 for fixation by Rubisco in the Calvin cycle. Decarboxylation is carried out by one or more of three enzymes — NAD-malic enzyme (NAD- ME), NADP-ME, phosphoenolpyruvate carboxykinase (PEP-CK), depending on the biochemical subtype. The active role of Carbonic Anhydrase (CA) in C4 photosynthesis, as well as plant growth, paved the path to explore its potentiality to generate a functional C4 rice plant exhibiting a higher rate of photosynthesis via proper genetic regulation and expression of at least some of the CA in rice mesophyll cell cytosol (Chatterjee et al 2021). Also the studies conducted by Chatterjee et al (2021) showed that a CA gene mutant (*low CO2 responsive mutant 1,lcr1*) display stunted growth at ambient *p*CO2 whereas, their growth restored at elevated *p*CO2.

A typical monocot C_4 plant exhibits the Kranz anatomy with every mesophyll cell is in direct contact with an adjacent bundle sheath cell which in turn is directly in contact with a vein. The current strategy is aimed at generating C_4 photosynthesis with Kranz anatomy, the so-called "proto-Kranz" anatomy. In order understand the underlying mechanism; several researches have been focused on comparative transcriptomic studies that provide genome-wide expression profiles in C_3 versus C_4 plants, at different stages of C_4 development and in bundle sheath versus mesophyll cells (Wang et al 2017).

Rice exhibits higher mesophyll transfer conductance, greater stromal CO_2 content, lower CO_2 compensation points at warm temperature and less oxygen sensitivity of photosynthesis than cool temperate grasses. Rice vein length per leaf, mesophyll thickness and intercellular space volume are intermediate between those of most C_3 and C_4 grasses, indicating that the introduction of Kranz anatomy into rice may not require radical changes in leaf anatomy; however, deep lobe of chlorenchyma cells may constrain efforts to engineer C_4 photosynthesis into rice (Sage et al 2009).

In order to achieve the proto-Kranz anatomy, Wang et al (2017) introduced maize *GOLDEN2-LIKE* genes leading to increased mitochondria and chloroplast development followed by increased accumulation of photosynthetic enzymes and increase in volume of sheath cells surrounding the veins.

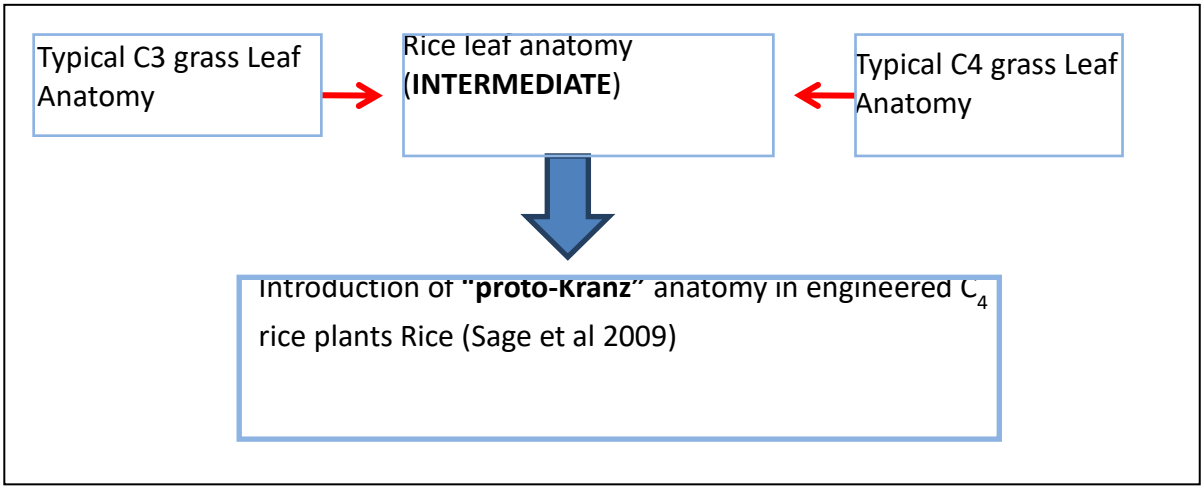

Fig 2: Enhancing photosynthetic efficiency in rice plant

Aiming to determine the photosynthetic light-use efficiency of a leaf, Song et al (2016) developed a 3-D model which pointed out that different chloroplasts can experience drastically different light conditions, even when they are located at the same distance from the leaf surface; bundle sheath extensions, which are strips of parenchyma, collenchyma or sclerenchyma cells connecting the vascular bundles with the epidermis, can influence photosynthetic light-use efficiency of leaves; and chloroplast positioning can also influence the light-use efficiency of leaves (Fig 3).

Leaf hydraulic conductance and mesophyll conductance both represent major constraints to photosynthetic rate. Leaf hydraulic conductance inside xylem, leaf hydraulic conductance outside xylem, stomatal conductance and anatomical and structural leaf traits in 11 *Oryza* genotypes were investigated by Xiong et al (2016) to elucidate the correlation of H_2O and CO_2 diffusion inside leaves. All of the leaf functional and anatomical traits varied significantly among genotypes and it were proved that leaf hydraulic conductance and mesophyll conductance are related to leaf anatomical and structural features.

Conclusion

The present study reviews an overall analysis of seed morphology and agronomic characters to explore the worldwide focus on rice as a major food crop. Additionally from the further review of literature, it was established that distinct physiochemical, as well as molecular techniques, were extensively studied in different rice varieties. Molecular techniques like marker-assisted selection with a combination of conventional breeding in correlation with agronomic characters might become more useful in exploration of the rice indigenous varieties present. Morphological markers are reliable means of superior varietal selection. However, detection of QTL is limited in this case due to the effect of differential environmental response. Biochemical (isozyme) markers on the other hand have been used to

study linkage relationships and for genetic analysis (Agarwal et al 2008) in rice. Although conventional breeders depend on a combination of these techniques; environmental influence, role developmental stage and a low number of biochemical markers hinder unbiased selection. These limitations are largely overcome by the use of DNA markers. Genome Wide Association Studies (GWAS) involving statistics based phenotypic and genotypic data correlation in order to reveal markers located adjacent to the locus controlling trait of interest (Shabir et al 2017).

As growing of local conventional cultivars is highly cost-effective thus more agricultural practices including these local varieties must be encouraged. Thus from the present overall study of seed morphology and agronomic characters of rice basically might establish a small but interesting avenue for future aspects by exploring them at genetic and molecular level.

Future prospects

Rice is a major food crop in the cereal group around the world; so major attention remains essential to improve yield and quality of rice. This task can be achieved by harnessing novel alleles from available germplasm, including wild species and the use of modern molecular techniques helpful in developing high yielding rice varieties. In this situation, it is supposed that molecular marker application in genetic mapping will enable the rice breeders to detect the genes controlling agronomically important traits. The high-throughput techniques result in discovery of molecular markers that will be useful in identifying the rice genotypes carrying desired characters as these have been effectively used to develop linkage maps and mapping genes required for varietal development. In general, the selection of a molecular marker technique is based on reliability, statistical power and level of polymorphisms. When these marker techniques reach a higher degree of automation then it will be suitable to use DNA markers directing to a new “Green Revolution” in the agricultural world. Presently, the enormous development of more efficient DNA markers will go on in future, because they can serve as an important tool for plant breeders and geneticists to develop the cultivars of rice for food security and sustainable productivity.

Seeds comprise a protective covering, a small embryonic plant, and a nutrient-storage organ rich in protein. Seed storage proteins (SSP) have been studied for decades by cell biologists, and many of the complicated aspects of their processing, assembly, and compartmentalization are now well understood. While much of the data from mass spectrometry-based proteomic analysis of seeds is descriptive, it has nevertheless provided a preliminary metabolic picture explaining much of their biology. Contemporary studies are moving more toward analysis of protein interactions and posttranslational modifications, and functions of metabolic networks.

Many aspects of the biology of seeds make then an attractive platform for heterologous protein expression.

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Many facets of reactions of thiocyanate anions with bare and complexed copper(II) ions

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Abstract: Solution phase reactions of transition metal ions with small anions in the presence and absence of supporting anionic or neutral ligand system give variety of products. Such reactions using SCN^- with bare copper(II) ions and ligand anion bound copper(II) ions provided CuSCN, $\{[Cu^{II}_2(\mu\text{-}L)(\mu\text{-}H_2O)\cdot H_2O][Cu^{I}(1,3\text{-}NCS)_2]\}_n$ and $\{[Cu^{II}_2(L^1)_2][Cu^{I}_4(1,3\text{-}SCN)_4(1,1,3\text{-}SCN)_2]\}_n$ respectively. When preformed precursor complex is used, the terminal and bridging ligand substitution as well as the extrusion of anion bound copper ions took place in a concerted manner. Physical characterization and X-ray structure analysis established the controlling factors that influence the identity of the resulting products. In one case, the competitive coordination behavior was observed, when both the ligand anion and the inorganic anion is available in the reaction medium.

Introduction: In organic solvent medium, the thiocyanate (SCN^-) anion can coordinate to the available metal ions in different coordination modes, endowing the solid surfaces of the products with different structures, electronic and catalytic properties. Thiocyanate anion (SCN^-) is a well-known inorganic species and is widely used in solid-state chemistry. As nitrogen atom in SCN^- anion is harder than sulfur atom, one may intuitively think that the preference of coordination modes of SCN^- anion can be explained and predicted by HSAB theory. SCN^- anion is special in that it can coordinate to the metal ion center through N or S atom. Since the electrons of S lie higher in energy than those of N due to the smaller electro negativity of S, S has a stronger preference to coordinate to the metal ion to maximize the covalent bonding interaction energy in terms of frontier molecular orbital interactions. However, S bearing with smaller negative charge than N thus has a smaller tendency to form electrostatic interaction with metal ion in terms of electrostatic interaction. Therefore, it is expected that sulfur prefers the metal ion that has low-lying LUMO to maximize the covalent bonding interaction term, while N favors metal bearing with a high positive charge to maximize the electrostatic interaction.

Copper(II) thiocyanate is a coordination polymer (CP) with formula $Cu(SCN)_2$.[1] It is a black solid which slowly decomposes in moist air. (Figure 1)[2] It was first described in 1838 by Carl Ernst Claus and its structure is determined in 2018.[3]

Figure1. Black powder of $Cu(SCN)_2$

The structure of $Cu(SCN)_2$ was determined *via* powder X-ray diffraction and consists of chains of $Cu(NCS)_2$ linked together by weak Cu–S–Cu bonds into two-dimensional layers. Jahn-Teller distortion is present within the structure and, each copper(II) center is octahedral and coordinated by four sulfur and two nitrogen atoms. The sulfur end of the SCN^- ligand is doubly bridging. (Figure 2)

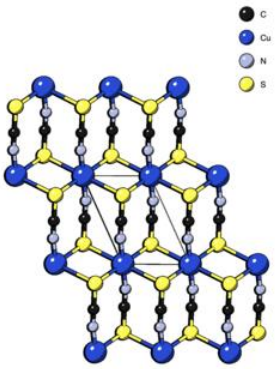

Figure 2. Crystal structure of copper(II) thiocyanate

Copper(II) thiocyanate, like copper(II) bromide and copper(II) chloride, is a quasi-low-dimensional antiferromagnet and it orders at 12K into a conventional Néel ground state. Pure copper(II) thiocyanate can be obtained as a black or dark-brown solid from the reaction of concentrated solutions of copper(II) and a soluble ammonium or potassium thiocyanate salt in water. With rapid drying, pure $Cu(NCS)_2$ can be isolated. Reaction at lower concentrations and for longer periods of time generates instead copper(I) thiocyanate. $Cu(NCS)_2$ is unstable and decomposes quickly to CuSCN according to reaction of following eq. 1.

$$Cu^{2+}(aq) + 2SCN^-(aq) \longrightarrow [Cu(NCS_2)](s) \longrightarrow CuSCN(s) + \tfrac{1}{2}(SCN)_2(g) \quad \ldots (1)$$

On standing, the precipitate decomposes to a white cuprous salt and the reduction process is accelerated by heating the solution. When the reaction mixture is heated in a bath of boiling water, the black precipitate immediately transformed to white CuSCN with vigorous gas evolution. The product isolated from the above reaction **1** is not only temperature but also concentration dependent. When 0.25 M solutions of $CuSO_4{\cdot}5H_2O$ and KSCN are mixed, no $Cu(SCN)_2$ forms, instead white CuSCN is precipitated after a few minutes at room temperature.

Solution reactivity of SCN^- anions in low concentration with complexed copper(II) ions can take a completely different course of action. The situation is further interesting when the reaction in non-aqueous medium is carried out with binuclear thiocyanate free copper(II) complex.[4, 5]

Over a decade ago, we showed that it is possible to synthesize a hetero valence copper(II) plus copper(I) based metal-organic framework structure $\{[Cu^{II}_2(\mu\text{-}L)(\mu\text{-}H_2O){\cdot}H_2O][Cu^{I}(1,3\text{-}NCS)_2]\}_n$ (**2**) from the precursor aqua-bridged $[Cu_2]$ complex $[Cu^{II}_2(\mu\text{-}L)(\mu\text{-}H_2O)]ClO_4{\cdot}1.5H_2O$ (**1**) of heptadentate (N_4O_3)imidazolidinylphenolate Schiff base ligand, H_3L.[6] (Figure 3) Thiocyanate coordination induced aqua bridge cleavage and reductive

extrusion of copper(I) ions lead to the formation of $Cu^{I}(NCS)_2^-$ anions as a molecular building block and generation of 1D anionic chains as an extended coordination framework host for **2** and quantitatively replace all the ClO_4^- ions from **1** *via* anion metathesis. Once formed these chains trap the original cationic $[Cu_2]$ complex part in a layer arrangement. The copper atoms of **2** stay in a distorted square-pyramidal environments of $Cu^{II}\cdots Cu^{II}$ separation of 3.29 Å. (Figure 4) Within the anionic layer part, the presence of two symmetric end-to-end thiocyanate bridges with Cu^{I}-SCN and Cu^{I}-NCS distances of 2.61 Å (av.) and 1.924 Å (av.), respectively, results in a $Cu^{I}\cdots Cu^{I}$ separation of 5.51 Å (av.) within the linear chain structure. The investigation specifies that the presence of Cu_2 based macro-cations play a critical role, like alkyl amine in zeolite synthesis, as template in the process of assembling **2**. Moreover, the structure of the polyanionic chains has great influences on the ultimate layering of the cationic Cu^{II}_2 units.

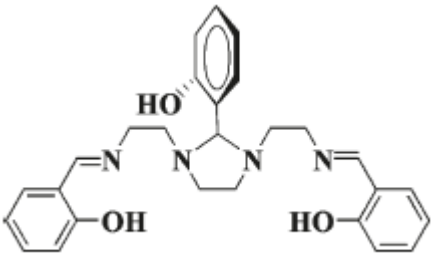

Figure3. Ligand H_3L

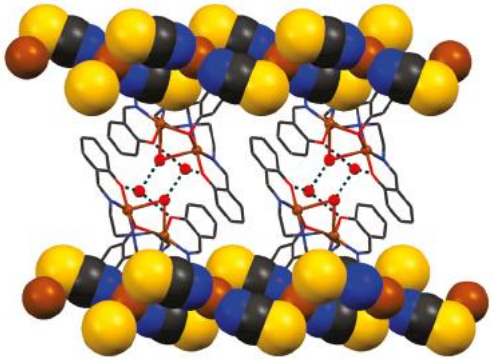

Figure 4. The 1D anionic chains in a spacefill model showing the coordination framework host

In 2013 Mitra et al.[7] showed that the reaction of reaction of $Cu(ClO_4)_2\cdot 6H_2O$ with HL^1 in presence of NaSCN led to the formation of $\{[Cu^{II}_2(L^1)_2][Cu^{I}_4(1,3\text{-}SCN)_4(1,1,3\text{-}SCN)_2]\}_n$ (**3**), through partial $Cu^{II} \rightarrow Cu^{I}$ reduction. (Figure 5) In **3**, the arrays of cationic $[Cu^{II}_2(L^1)_2]^{2+}$ units are inserted in between 2D layers of $\{[Cu^{I}_4(SCN)_6]^{2-}\}_n$ and connected *via* μ-1,1,3-SCN^- links giving a 3D network structure. In another attempt, reaction of $Cu(OAc)_2\cdot H_2O$ with HL^2 in the presence of NaSCN provided a mixed-valence pentanuclear cluster $\{[Cu^{II}_2(L^2)_2(NCS)]_2[Cu^{I}(SCN)(1,1\text{-}SCN)(1,3\text{-}SCN)]\}$ (**4**). In **4**, two cationic $[Cu^{II}_2(L^2)_2(NCS)]^+$units are bridged by the anionic $[Cu^{I}(SCN)_3]_2^-$ unit through long Cu–SCN links. (Figure 6)

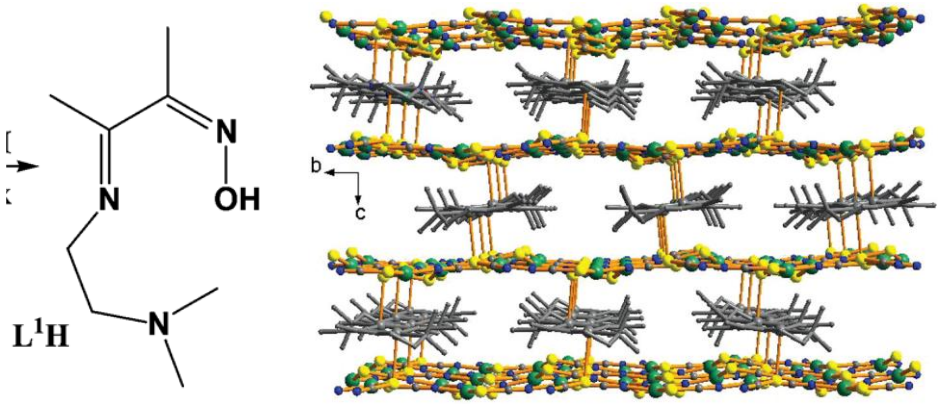

Figure 5. Ligand HL^1 and the sandwiched crystal packing of $Cu^{II}_2(L^1)_2$ within $Cu^{I}_4(1,3\text{-}SCN)_4(1,1,3\text{-}SCN)_2$

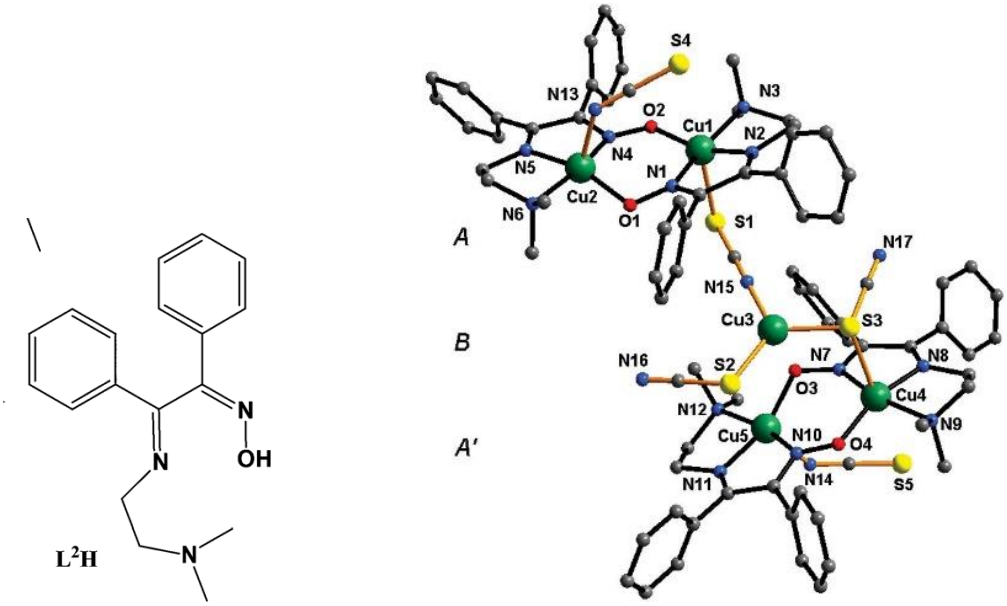

Figure6. Ligand HL^2 and the sandwiched crystal packing of $[Cu^{II}_2(L^2)_2(NCS)]_2$ connected to $Cu^{I}(SCN)(1,1\text{-}SCN)(1,3\text{-}SCN)$

Summary and Future Scope

This micro review thus clearly highlights the several aspects of reactions of SCN^- anions with bare copper(II) ions and copper(II) ions already connected to three different ligand systems. In case of **2** the selective coordination of SCN^- anion to one Cu^{II} removes the bridged water molecule. Wherein the coordination of three SCN^- ions to Cu^{II} ion is not permitted to provide anionic complex species like $[Cu(NCS)_3(OH_2)]^-$. Instead, partial reduction of metal ion centers following metathesis is observed for anionic coordination chain formation. Direct replacement of ClO_4^- anions by SCN^- anions is not observed due to the greater affinity of the copper(II) ions for SCN^- anions. The review work in this segment of experimental coordination chemistry thus clearly established the role of chelating organic ligand anions in stabilizing the copper(II) or copper(I) centers. Phenolate or oximate based donors try to stabilize the bivalent state without showing any kind of reduction reaction. When thiocyanate

anions are consumed for reduction reactions the reduced copper(I) states like to prefer the coordination with other available SCN^- anions in 1,1-, 1,3- and 1,1,3- coordination modes and many types of coordination chains. Thus the future endeavor in this direction could be directed for new ligand system incorporating N, O, S and P donor atoms. Getting synthetically feasible and electronically favorable ligand system would definitely be a challenge to any synthetic and structural chemist. Many such complexes of copper(I) thiocyanate-bridged systems with phosphine donor ligands can also function as luminescent material for optoelectronic components and devices.[8]

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Avian diversity in pond ecosystems

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Abstract:

An ecosystem is a complex set of relationships among living resources, habitats and nature. India is blessed with a wide variety of ecosystems. But these are being disturbed increasingly. Of all animals, avians have been the well-known group with which the human beings associated for various purposes (food, communication, pollination, pets etc.). Also, birds are important for biological control in a number of cases.

Thus, an avifaunal diversity and abundance were studied in two managed ponds (those used for extensive fish culture) and in two unmanaged ponds (those that were not used for any commercial purpose). A total of thirty-two (32) species of birds were observed in this study conducted in February to April, 2011, belonging to ten (10) orders, namely **Passeriformes, Apodiformes, Piciformes, Ciconiformes, Anseriformes, Cuculiformes, Gallifoemes, Coraciiformes, Gruiformes, Psittaciformes**. The climatic and geophysical conditions of both the ponds are almost similar. The dominant orders of resident birds were Passeriformes, Cuculiformes, Coraciiformes with a frequency of occurrence 100%, the rest were Anseriformes and Gruiformes with a frequency of occurrence 50% and 25% respectively; while only one migratory bird *Anas acuta* (Anseriformes) with frequency of occurrence 25% was found in an unmanaged pond. Similarity Indices (Sorenson's Similarity Indices & Renkonen's Percentage Similarity Indices) and Diversity Indices (Shannon-Weiner Function) were calculated to check the differences between managed and unmanaged ponds. Between the two managed ponds, Similarity Indices were high (Sorenson's Similarity Indices-0.8; Renkonen's Percentage Similarity Indices 98%). The same was true for the two unmanaged ponds (Sorenson's Similarity Indices-0.74; Renkonen's Percentage Similarity Indices above 90%). However, Shannon –Weiner Function of species diversity showed a slightly higher value of 2.8 in unmanaged ponds against 2.4 in managed ponds. The comparative assessment therefore shows that a higher diversity of bird species was found in unmanaged ponds.

Key words: *Avifauna, Unmanaged ponds, Managed ponds, Similarity Indices, Diversity Indices, Avifaunal diversity.*

Introduction

Ornithological research has always played a central role in the development of certain aspects of our science. Birds are the most conspicuous and significant component of freshwater wetland ecosystem (Tabur and Ayvaz, 2010) and avian species richness is largely dependent upon the presence of water bodies of a particular area. The functional role of birds in the ecosystem is considered as potential pollinators and scavengers. Despite their importance for maintaining ecological balance, bird species are being threatened due to habitat loss, human persecution and introduced predators. Birds, being most diverse communities and living a variety of habitat niches, are potentially useful as indicators of habitat changes and for other conservation-oriented approaches. Measures of diversity are frequently used as indicators of the wellbeing of ecological systems. Understanding such dynamic patterns of diversity is dependent on the methods of estimation employed. If there are several methods to choose, it can sometimes be difficult to decide on the most suitable methods of measuring diversity. Here, one of the methods (i.e. Point Count method) was taken to make a comparative assessment relating to the diversity of bird species between managed (those used for extensive fish culture) and unmanaged (those that are not used for any commercial purpose) water bodies in a semi-rural area.

Therefore, the specific objectives are:

1. To catalogue the number of birds and tree species observed in the locality
2. To find the best time for bird's watching
3. Check for similarity and diversity indices for comparative assessment

Materials and methods

Study area:

The study was done in Nabagram Gram Panchayat area, situated in the west of Konnagar railway station in Hooghly district (**Figure 1**). Sites were selected by using topographic map collected from Nabagram Gram panchayat office and with the help of the Google earth. A total of 4 ponds were chosen for this research. The details of the ponds selected for this study

are provided in table 1 ponds were categorized into managed and unmanaged ponds. Both the managed ponds are used for commercial fishing. The managed ponds were maximally surrounded by cluster of bamboo trees and one of their banks is partially covered by the holdings, whereas the banks of unmanaged pond 1 and 2 are fully covered by the trees.

Methods used for the study:

Bird watching and recording of relevant data were carried out during the period from February to April, 2011. As the water bodies (managed) are in close approximation and the two ponds shared a common pond bank, birds perch and move on trees of all banks, thus, bird watching was done without differentiating respective water bodies. The observations were made by point count method, where the observer stopped for 2mins and recorded the bird species (Nur et al., 1999; Verma, 2000). Observation was made for five consecutive days from 6 AM to 12 Noon with the help of a binocular. Photographs of birds were taken by a Canon camera and the birds were identified by using standard books such as (*Books of Indian Birds* by Salim Ali (2002) and *The World Atlas of Birds,* Edited by Scott. P (2006).

Indices calculation and Statistical Analysis:

The following were calculated from the number counts recorded:

(i) Frequency (%) = T_1/T_2 [Where, T_1 = Total No. of pond in which species occur
T_2 = Total No. of pond studied]

(ii) Abundance = Frequency/100

(iii) Diversity (Order) = T_s/ T_p [Where, T_s = Total No. of species found in pond
T_p= Total No of found in one pond]

Species diversity and similarity indices were calculated following Krebs (1989) and Magurran (2004). The formulas are given below:

Species diversity was calculated using Shannon index. It was calculated from the equation:

(iv) $H' = \sum_{i=1}^{s} (p_i)(\log_2 p_i)$ [Where, H' = Information content of sample (bits/individual)
= Index of species diversity
s = Number of species
p_i = proportion of total sample belonging to *ith* species.]

Jaccard and Sorenson's Similarity Index and Renkonen's Percentage Similarity index for assessing the similarity between unmanaged pond 1 and 2 and managed pond 1 and 2. It was calculated from the equation:

(v) Jaccard $C_j = j/a+b-j$ [Where, j = the no. of species found at both site A and B

(vi) Sorenson's $C_s = 2j/a+b$ a = the no. of species in site A and b = the no. of species found in site B]

(vii) Renkonen's $P = \sum \text{minimum } (p_{1i}, p_{2i})$

[Where, p = percentage similarity between site 1 and 2

P_{1i} = Percentage of species I in community sample 1

P_{2i} = Percentage of species I in community sample 1]

Statistical analysis (t-test between two groups) was also performed to compare between the pond types in respect of bird and tree species diversity.

Results and discussions

A total of thirty-two (32) species of birds distributed in 10 different orders were observed in this study. The list of bird species in accordance with their presence or absence are reported in **Table 2**. The bird species observed was slightly higher in unmanaged ponds (n= 45) than in managed ones (n=41). Overall the frequency dominance of orders, namely **Passeriformes, Apodiformes, Piciformes, Ciconiformes, Anseriformes, Cuculiformes, Gallifoemes, Coraciiformes, Gruiformes, Psittaciformes** were framed in a pie diagram in the **Figure 2a** and **2b** for unmanaged and managed pond respectively. The graph, irrespective of pond types, reflects that Passeriformes is the most frequently found order followed by Ciconiformes in unmanaged ponds and Piciformes in managed ponds. In **Figure 3**, overall comparative distribution (order wise) of species showed that birds belonging to 60% orders were found in unmanaged water bodies.

The dominant orders of resident birds were Passeriformes, Cuculiformes, Coraciiformes with a frequency of occurrence 100%, the rest were Anseriformes and Gruiformes with a frequency of occurrence 50% and 25% respectively; while only one migratory bird *Anas acuta* (Anseriformes) with frequency of occurrence 25% was found in an

unmanaged pond (**Table 3**). Among total number of bird species twenty-six (n=26) are residential, four (n=4) are residential-migratory and only two (n=2) are migratory (**Table 4**). Additionally, when the observation time is divided into 3 slots, it was interestingly found that 7 to 9 AM in the morning is the best time to observe birds for this locality (**Figure 4**). Simultaneously, the number of tree species were indirectly affected birds' diversity. Observation related to presence of tree species surrounding the ponds also suggested that managed ponds have a very less number of trees compared to unmanaged ones and the difference is significant (**Figure 5**). This might also indicate the presence of more disturbances in managed pond areas. Similarity Indices (Sorenson's Similarity Indices & Renkonen's Percentage Similarity Indices) and Diversity Indices (Shannon-Weiner Function) were calculated to check the differences between managed and unmanaged ponds and are reported in **Table 5 and 6** respectively. Between the two managed ponds, Similarity Indices were high (Sorenson's Similarity Indices-0.8; Renkonen's Percentage Similarity Indices 98%). The same was true for the two unmanaged ponds (Sorenson's Similarity Indices-0.74; Renkonen's Percentage Similarity Indices above 90%), thereby showing similarity between the two managed and two unmanaged ponds. Though similarity was more observed in managed compared to unmanaged ponds. However, Shannon –Weiner Function of species diversity showed a slightly higher value of 2.8 in unmanaged ponds against 2.4 in managed ponds may indicate bird diversity was slightly higher in unmanaged ponds. However, no significant difference was found between the two diversity measure. But when we observed the difference day-wise the number of bird species was significantly high in unmanaged ponds.

Though the climatic and geophysical conditions of both the ponds are almost similar, there are differences in terms of biodiversity elements. Fish eating birds like Kingfisher were found more in managed ponds. Due to the excessive interruption of fisherman, numbers of trees surrounding the pond banks were low. The unmanaged ponds on the other hands maintain their natural vegetation because these water bodies were not used for any commercial purpose. Thus, the comparative assessment therefore shows that a higher diversity of bird species was found in unmanaged ponds.

Other studies related to avian diversity in aquatic ecosystem also showed Passeriformes as dominant order of birds (Patra & Chakrabarti 2014; Rahalkar & Tiwari 2014) and birds were found to be different with varying habitats (Kumar and Gupta 2009).Village and semi urban ponds were also reported as a representative niche of bird species as our results revealed

(Rahalkar & Tiwari 2014). Similar to our study, conservation risks of birds in ponds due to human activities was also reported by Kumar and Gupta in 2009 and future of this avian fauna is in danger due to unchecked growth of different areas around water waterbodies (Patra & Chakrabarti 2014).

Acknowledgement

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Tables and Figures

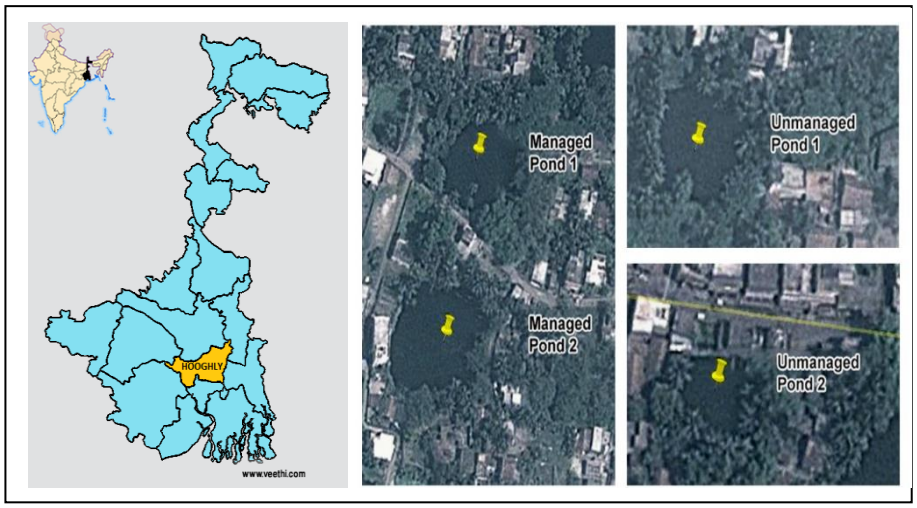

Figure 1. Study sites

Table 1. Location of study sites (managed and unmanaged ponds)

	Ponds	Location	Latitude	Longitude	Diameter	Distance from the Konnagar Railway Station
Unmanaged	Pond 1	Kanaipur , Hooghly District	22^0 42’7.31^{0}N	$88^0$19’33.97^{0}E	100ft/60ft	1.5 kms
	Pond 2	Kanaipur , Hooghly District	$22^0$41’53.16^{0}N	$88^0$19’25.06^{0}E	60ft/40ft	1.5 kms
Managed	Pond 1	Bansai, Hooghly District	22^0 42’5.19^{0}N	$88^0$19’1.08^{0}E	110ft/90ft	2 kms
	Pond 2	Bansai, Hooghly District	$22^0$42’3.08N	$88^0$19’0.95N	125ft/80ft	2 kms

Table 2. List of avifauna according to their presence absence in the study sites

				Unmanaged		Managed	
Sl.No	**Name of the species**	**Common name**	**Order**	**pond 1**	**pond 2**	**pond 1**	**pond 2**
1	*Copsychus saularis*	Oriental magpie robin	Passeriformes	+	+	+	+
2	*Passer domesticus*	House crow	Passeriformes	+	-	+	+
3	*Streptopelia chinensis*	Spotted dove	Galliformes	+	+	+	+
4	*Dicurus macrocercus*	Black drongo	Passeriformes	+	+	+	+
5	*Megalaima hemacephala*	Copper smith barbet	Piciformes	-	-	+	+
6	*Orthotomus sutorius*	Common tailor	Passeriformes	+	+	+	+
7	*Dendrocitta vagabanda*	Tree pie	Passeriformes	+	-	+	+
8	*Acridotherus tritis*	Common mayna	Passeriformes	+	+	+	+
9	*Oriolus chinensis*	Black headed oriole	Passeriformes	+	+	-	-
10	*Halcyon smyrnensis*	White breasted kingfisher	Coraciformes	+	+	+	+
11	*Dinopium benghalense*	Lesser golden black woodpecker	Piciformes	-	-	+	+
12	*Pelecanus onocrotalus*	Great white pelican	Ciconiformes	+	-	+	-
13	*Bubulcus ibis*	Cattel egret	Gruiformes	+	-	-	-
14	*Psittacula krameri*	Rose ringed parakeet	Pssittaciformes	+	+	-	-
15	*Psittacula eupatris*	Alexandrine parakeet	Pssittaciformes	+	+	-	+
16	*Ardeola grayii*	Indian pond heron	Ciconiformes	+	+	+	+
17	*Aythya ferina*	Common poachard	Anseriformes	+	+	-	-
18	*Dryocopus javensis*	Great black woodpeaker	Piciformes	+	-	+	-
19	*Pericrocotus flammens*	Scarlet Minivet	Passeriformes	-	-	+	+

20	*Pycnonotus cafer*	Red vented bulbul	Passeriformes	+	+	+	+
21	*Sturnus contra*	Asian pied starling	Passeriformes	+	-	-	+
22	*Glucidium radiatum*	Jungle owlet	Apodiformes	+	-	+	-
23	*Eudynamys scolopacea*	Asian Koel	Cuculiformes	+	+	+	+
24	*Columba livia*	Pegion	Galliformes	+	+	+	-
25	*Passer domesticus*	House sparrow	Passeriformes	+	+	-	-
26	*Fulica atra*	Common coot	Anseriformes	+	-	+	+
27	*Centropus sinensis*	Greater coucal	Cuculiformes	-	+	+	+
28	*Anus acuta*	Bali hans	Anseriformes	+	-	-	-
29	*Turdiodes caudatus*	Common babbler	Passeriformes	-	+	-	-
30	*Cypsiurus balasinensis*	Palm swift	Apodiformes	+	+	-	-
31	*Milvus migrans*	Black Kite	Ciconiformes	+	-	+	-
32	*Corvus corax*	Common raven	Passeriformes	+	+	+	+
			Total No. of species	27	18	22	19

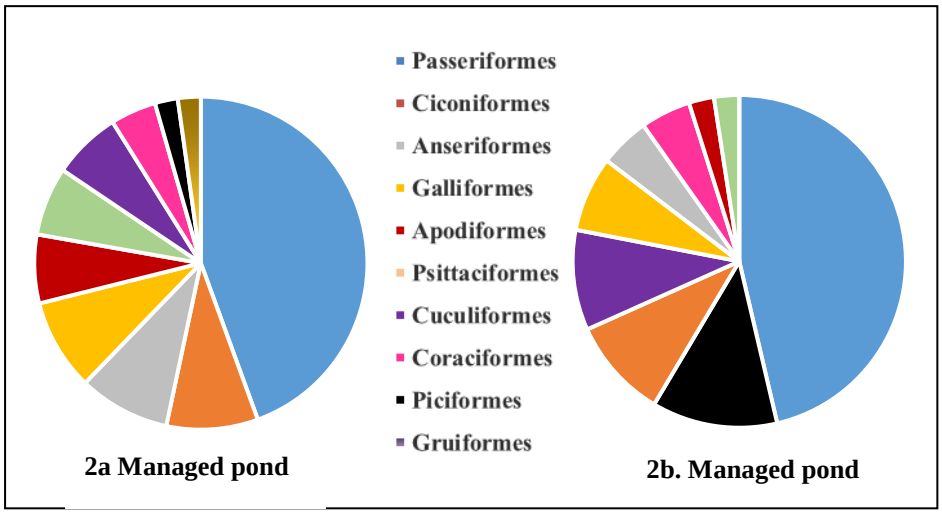

Figure 2. Order frequency of bird species found in Unmanaged (a) and managed ponds (b).

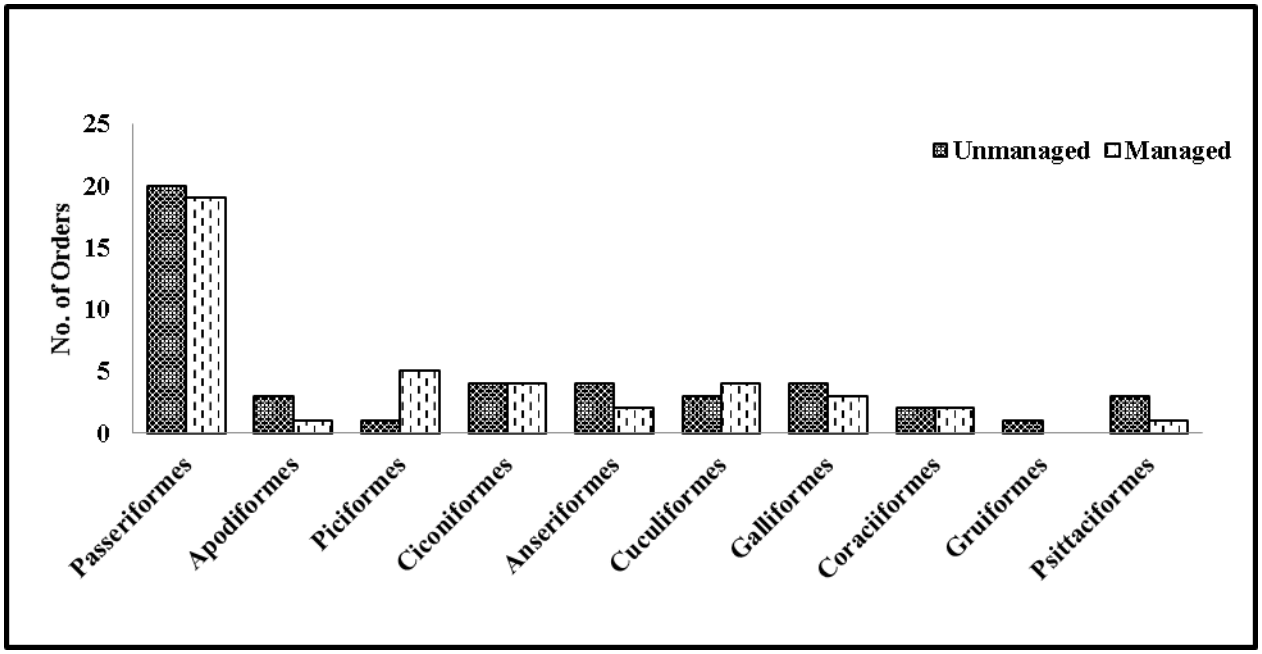

Figure 3. Order wise distribution of bird species in unmanaged & managed water bodies

Table-3 Frequency and abundance of avifauna recorded around four studied ponds (two unmanaged and two managed)

Sl.No	Name of the species	Common name	Order	Habitat	Frequency	Abundance
1	*Copsychus saularis*	Oriental magpie robin	Passeriformes	R	100%	1
2	*Passer domesticus*	House crow	Passeriformes	R	75%	.75
3	*Streptopelia chinensis*	Spotted dove	Galliformes	R	100%	1
4	*Dicurus macrocercus*	Black drongo	Passeriformes	R	100%	1
5	*Megalaima hemacephala*	Copper smith barbet	Piciformes	R	50%	.50
6	*Orthotomus sutorius*	Common tailor	Passeriformes	R	100%	1
7	*Dendrocitta vagabanda*	Tree pie	Passeriformes	R	75%	.75
8	*Acridotherus tritis*	Common mayna	Passeriformes	R	100%	1

9	*Oriolus chinensis*	Black headed oriole	Passeriformes	RM	50%	.50
10	*Halcyon smyrnensis*	White breasted kingfisher	Coraciformes	R	100%	1
11	*Dinopium benghalense*	Lesser golden black woodpecker	Piciformes	R	50%	.50
12	*Pelecanus onocrotalus*	Great white pelican	Ciconiformes	RM	50%	.50
13	*Bubulcus ibis*	Cattel egret	Gruiformes	RM	25%	.25
14	*Psittacula krameri*	Rose ringed parakeet	Pssittaciformes	R	25%	.25
15	*Psittacula eupatris*	Alexandrine parakeet	Pssittaciformes	R	50%	.50
16	*Ardeola grayii*	Indian pond heron	Ciconiformes	R	100%	1
17	*Aythya ferina*	Common poachard	Anseriformes	M	50%	.50
18	*Dryocopus javensis*	Great black woodpeaker	Piciformes	R	25%	.25
19	*Pericrocotus flammens*	Scarlet Minivet	Passeriformes	R	50%	.50
20	*Pycnonotus cafer*	Red vented bulbul	Passeriformes	R	100%	1
21	*Sturnus contra*	Asian pied starling	Passeriformes	R	50%	.50
22	*Glucidium radiatum*	Jungle owlet	Apodiformes	R	50%	.50
23	*Eudynamys scolopacea*	Asian Koel	Cuculiformes	R	100%	1
24	*Columba livia*	Pegion	Galliformes	R	75%	.75
25	*Passer domesticus*	House sparrow	Passeriformes	R	50%	.50
26	*Fulica atra*	Common coot	Anseriformes	RM	75%	.75
27	*Centropus sinensis*	Greater coucal	Cuculiformes	R	75%	.75
28	*Anus acuta*	Bali hans	Anseriformes	M	25%	.25
29	*Turdiodes caudatus*	Common babbler	Passeriformes	R	25%	.25
30	*Cypsiurus balasinensis*	Palm swift	Apodiformes	R	50%	.50

31	*Milvus migrans*	Black Kite	Ciconiformes	R	50%	.50
32	*Corvus corax*	Common raven	Passeriformes	R	100%	1

R= residential M= Migratory RM= Residential Migratory

Table 4. Number of species and their Frequency of Occurrence found in the two pond types based on their Habitats

Habitats	Number of species	Managed ponds		Unmanaged ponds	
		No. of species	Freq. of occurrence	No. of species	Freq. of occurrence
Residential (R)	26	11	100 50	15	100 75 50
Residential-Migratory (RM)	4	-	50	4	-
Migratory (M)	2	-	-	2	50 25

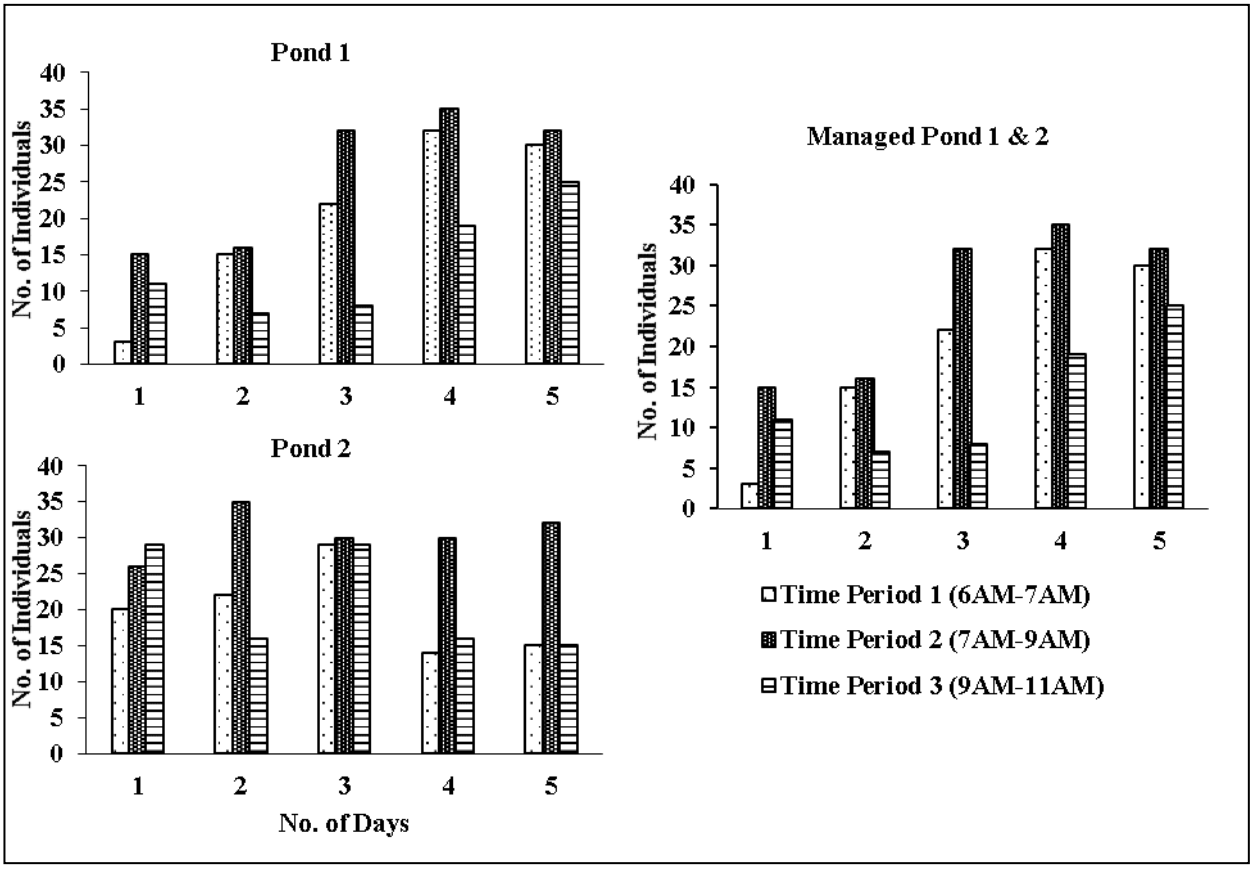

Figure 4. Showing the best time for bird watching.

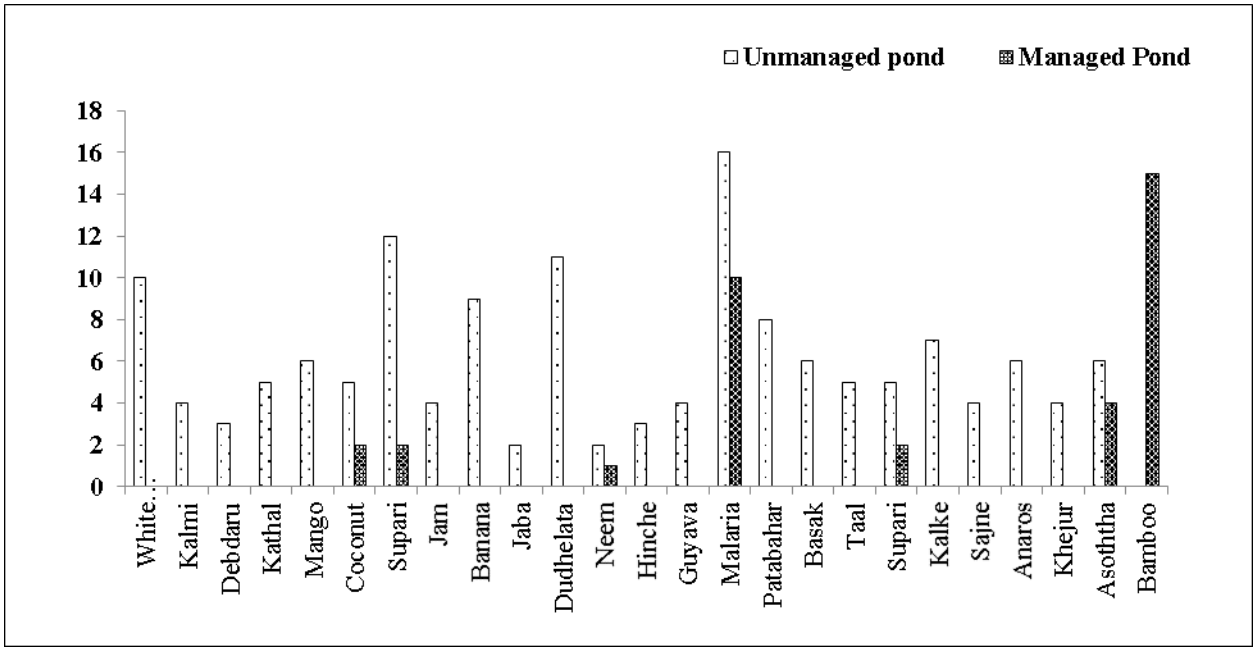

Figure 5. Comparative assessment of number of trees in the managed and unmanaged pond types.

Table5. Similarity Indices between two managed ponds and two unmanaged ponds

Similarity Indices			
Sl.No.	Name of the Indices	Value	
		Managed Pond	Unmanaged Pond
1	Jaccard Similarity Indices (Cj= j/a+b-j)	0.8	0.6
2	Sorenson's Similarity Indices (Cs=2j/a+b)	0.8	0.7
3	Renkonen's Percentage Similarity Indices [P= Σminimum (pi1,pi2)]	98	90

Table-6 Diversity Indices between managed and unmanaged ponds

Diversity Indices			
Name of the Indices	Value (in bits per individual)		
Shanon-Weiner Function [H'= ∑pi ln(pi)]	Unmanaged Pond 1	Unmanaged Pond 2	Managed pond 1 & 2
	2.77	2.69	2.45

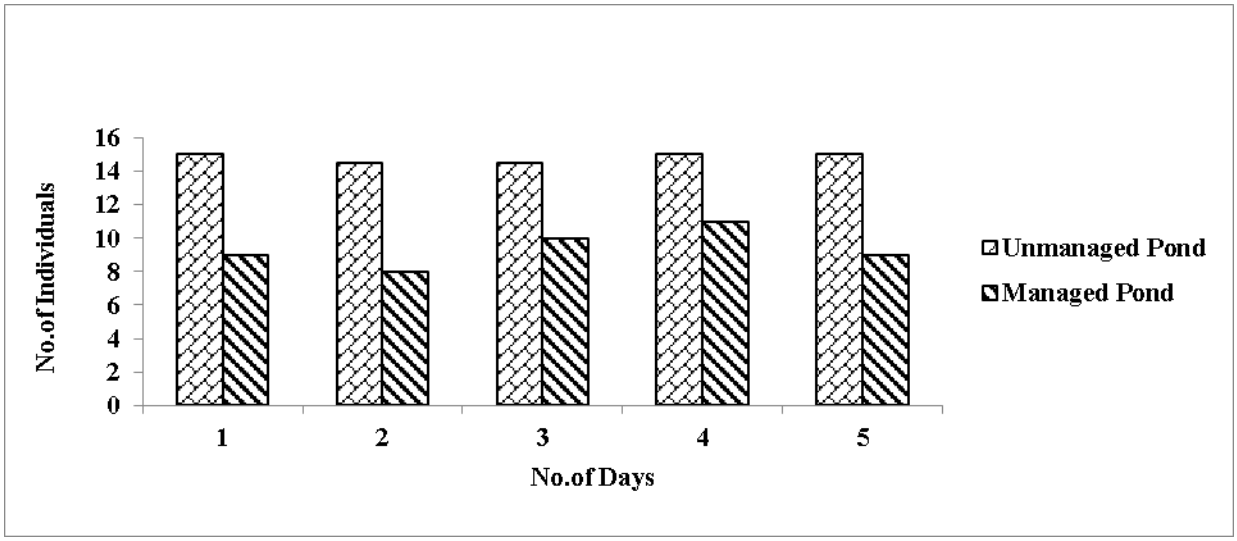

Fig.6 Comparative figures of bird's species diversity found in unmanaged & managed water bodies

Effect of sublethal doses of Cypermethrin on the haemocytes of *Periplaneta americana* (Dictyoptera: Blattidae)

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Abstract: The American cockroaches, *Periplaneta americana* (Linnaeus) are omnivorous insects and spread a great number of diseases world-wide. Hematological studies are very important in insect physiology because the haemocyte performs various physiological functions in the body. Cypermethrin exhibited the enormous changes to total and differential haemocyte count after 24 hours exposure. The action of Cypermethrin at various sublethal doses (0.008%) and (0.02%) against American cockroaches was introduced to study Total Haemocyte Count (THC) and Differential Haemocyte Count (DHC). Six different types of haemocytes had been observed in the haemolymph, including Prohaemocytes (PRs), Plasmocytes (PLs), Spherulocytes (SPs), Oenocytoids (OEs), Adipohaemocytes (ADs), Coagulocytes (COs). The average number of blood cells counted was higher in male as compared to female. The number of blood cells counted under the microscope after the use of 0.008% and 0.02% of insecticides were significantly decreased in adult male and female cockroaches. It had been observed that the numbers of blood cells greatly reduced after the application of 0.02% Cypermethrin (10% EC) as compared to 0.008% on the haemolymph of adult cockroaches.

Keywords: *Cypermethrin, haemocytes, American cockroaches.*

Introduction: *Periplaneta americana* (Linnaeus) **(Dictyoptera: Blattidae)** are commonly known as the American Cockroaches. They are usually omnivorous insects, feed on great variety of food items and are found almost in everywhere. The haemocytes are cells that circulate in the haemolymph of insects, providing quick and efficient response against pathogens that invade the haemocoel (de Andrade et al., 2010). They are motile and phagocytic with lysosomal vesicles, and play important role in the immune system of invertebrates. Cypermethrin is a synthetic, pyrethroid insecticide that has high insecticidal activity, low avian and mammalian toxicity, and adequate stability in air and light (Kaufman et al .,1981, and U.S.D.A., 1995). Cypermethrin is a stomach poison as well as a contact insecticide (Jin and Webster, 1998). Various literatures reported on effect of Lambda Cyhalothrin and Deltamethrin on the haemocytes of desert locust by Khalid and Anjum (2001); haemocyte types and total and differential counts of Dipteran larvae by Silva et al. (2002); the haemocyte types, differential and total count on Lepidoptera by Jalali, & Salahi, (2008); effect of Methoprene on total haemocyte counts and histopathology of haemocytes on Lepidoptera by Sendi and Salehi (2010); effects of the pyrethroid insecticide Deltamethrin on the haemocytes of Lepidopteran larvae by Kurt and Kayiş (2015); toxicity of some insecticides to the haemocytes of giant honeybee by Perveen and Ahmad (2017); histopathological effect of Deltamethrin on the mid-gut of American cockroach by Majumdar et al. (2016).

Hematological studies are very important in insect physiology because the haemocyte performs various physiological functions in the body. The primary functions of haemocytes are: coagulation to prevent loss of blood, phagocytosis, encapsulation of foreign bodies in the insect body cavity, nodule formation, detoxification of metabolites and biological active materials and distribution of nutritive materials to various tissues and stored them also and may be hormones (Garcia and Rosales, 2002; Zhou *et al*., 2004; Ling and Yu, 2006; Ribeiro and Brehelin, 2006; Siddiqui and Al-Khalifa, 2012; Chavan *et al*., 2017).

Environmental pollutants such as insecticides, pesticides and heavy metals cause huge structural changes to haemocytes. These changes can be used to characterize the genotoxic, physiological, and biochemical effects of pollutants. Therefore, *P. americana* can be treated as laboratory model organisms in endocrinology, entomology, reproductive physiology because of their availability, ease of rearing, short life cycle and can be able to show results within few days.

The present study deals with the effect of most commonly used insecticide Cypermethrin (10% EC) on the haemolymph of *P. americana*. It aims to observe the total and differential haemocyte counts of adult male and female cockroaches and also to record the abnormalities caused by the insecticide on the haemolymph of adult *P. americana*.

Materials and Methodology: The adult male and female American cockroaches were collected during February-March, 2019 from the manhole in Kolkata (22.5880° N, and 88.3680° E), West Bengal. They were kept under suitable environmental conditions and the photoperiod of 12 hours light and 12 hours dark were also maintained. They were kept in plastic jars and upper side of the jars was perforated so that they could get oxygen. The cockroaches were allowed to eat bread crumbs. Daily feeding and cleaning were also maintained. Cypermethrin is a synthetic pyrethroid insecticide and is used to control wide variety of house-hold pests, spiders, flies, cockroaches, pests of fruit and vegetable crops. The chemical name of Cypermethrin (10% EC) is IUPAC: [Cyano- (3-phenoxyphenyl) methyl] 3-(2,2- dichloroethenyl)-2,2-dimethylcyclopropane-1-carboxylate. Cypermethrin concentration applied on the adult male and female cockroaches during experimentation is shown in Figure 1.

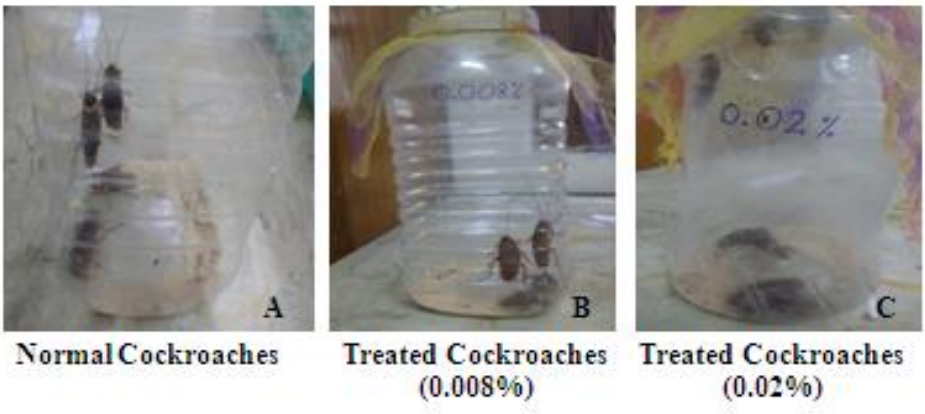

Fig1. Cypermethrin concentration on the adult male and female Cockroaches (*Periplaneta americana*)

Preparation of different insecticidal concentrations:-

0.1% stock solution of Cypermethrin (10% EC) was prepared in distilled water. Two experimental concentrations i.e. 0.02% and 0.008% were prepared from stock solution freshly through diluting stock solution in distilled water.

Application of insecticidal concentrations:-

Bread crumbs were thoroughly mixed with 2.5 ml of two different concentrations of insecticide (0.02% and 0.008%) in each Petri-dish. The Petri-dishes were placed in two separate plastic jars. Parallel to these control set up was also maintained.

Total Haemocyte Count (THC):-

The haemolymph of cockroach was collected into Thoma white blood cell pipette up to the 0.5 mark and it was then diluted up to 11 mark with Toissin's solution (NaCl = 1.0 gm, Na_2SO_4 = 8.0 gm, neutral glycerin = 20 ml, Methyl violet = 0.025 gm and Distilled water = 160 ml) upto the mark 11 (Mahmood and Yousaf, 1985). The pipette was shaken several minutes and the first 3-4 drops were discarded to avoid errors. Two drops of this solution were placed near the edge of the cover slip. Neubauer haemocytometer then automatically filled up the counting chambers by the capillary action. Bubbles should be avoided. Haemocytes counted in the four corners and one central chamber under the microscope. The haemocytes must be evenly distributed in the hemocytometer, if not, the sample was discarded. This process was repeated several times to obtain results. THC of both normal and treated cockroaches (0.02% and 0.008%) was studied under microscope. The number of circulating haemocytes of male and female cockroaches per cubic millimeter (mm3) was calculated using the formula, given by Jones (1962):

$$\frac{\text{Number of haemocyte counted per chamber X dilution X depth factor}}{\text{Number of 1 mm squares counted}}$$

Where, dilution = 20 times, Depth factor of the chamber = 10 (constant) and No. of squares counted = 5 for blood smear slide preparation.

Differential Haemocyte Count (DHC):-

Haemolymph preparation was done, according to Arnold and Hinks (1979). The cockroach was hold with fingers and the thoracic leg was amputated from the base of the femur by using sharp scissor. Haemolymph oozed out through the amputated leg, and the ooze was collected on the center of the clean glass slides by touching its leg. A thin blood smear was made by drawing a second slide over the first slide at 45⁰ angle. The slides were then allowed to dry for 1 minute, and fixed for 2 minutes with drops of absolute methyl alcohol. Fixed cells were

stained with Giemsa's solution (diluted 1 : 20 in distilled water) for 20 minutes, washed several times with tap water, and dipped into distilled water. The stained smears were air-dried and mounted in DPX with cover slip. The differential counting of haemocytes was observed under microscope (10X x 100X). DHC was studied in both control and treated cockroaches. The percentages of haemocytes were calculated by using the formula (Ghoneim et al., 2017) given below-

$$\frac{\text{Number of each haemocyte type}}{\text{Total number of haemocytes examined}} \times 100$$

Depending on the cell shape, cytoplasmic ratio, cytoplasmic inclusions and shape of nucleus, the free haemocytes in the haemolymph of cockroaches had been identified and distinguished in the present study.

Results and Discussions: Haemolymph of insect consists of fluid plasma and haemocytes. Numbers and sizes of circulating haemocytes vary in relation to age and life cycle stages of insect. Different types of haemocytes have important role in the protection of insects against invading pathogens and parasitoids. Tiwari and Shukla (2000) and Pandey et. al. (2008) reported the hematological changes of insect in response to the foreign invadaders. Cypermethrin acts as a contact poison as well as stomach poison in invertebrates. Higher dose of Cypermethrin immediately affects voltage dependent sodium channels by inhibiting ATPase enzymes in the nerve membrane of central nervous system (Jones, 1995).

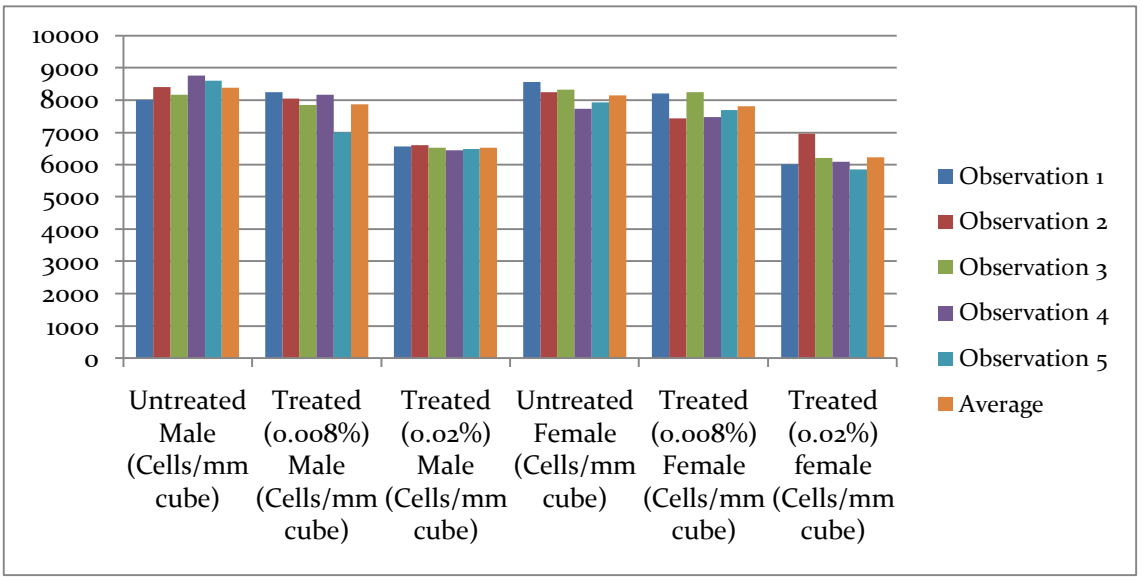

Fig 2: Comparative study of Cypermethrin on the Total Haemocyte Count (THC) of the adult *Periplaneta americana* after 24 hours exposure.

Total Haemocyte Count (THC)

Figure 2 shows the comparative study of Cypermethrin on the Total Haemocyte Count (THC) of the adult *Periplaneta americana* after 24 hours exposure. The total haemocyte count of

adult male and female *P. americana* was observed under microscope before and after the application of insecticide (Cypermethrin).

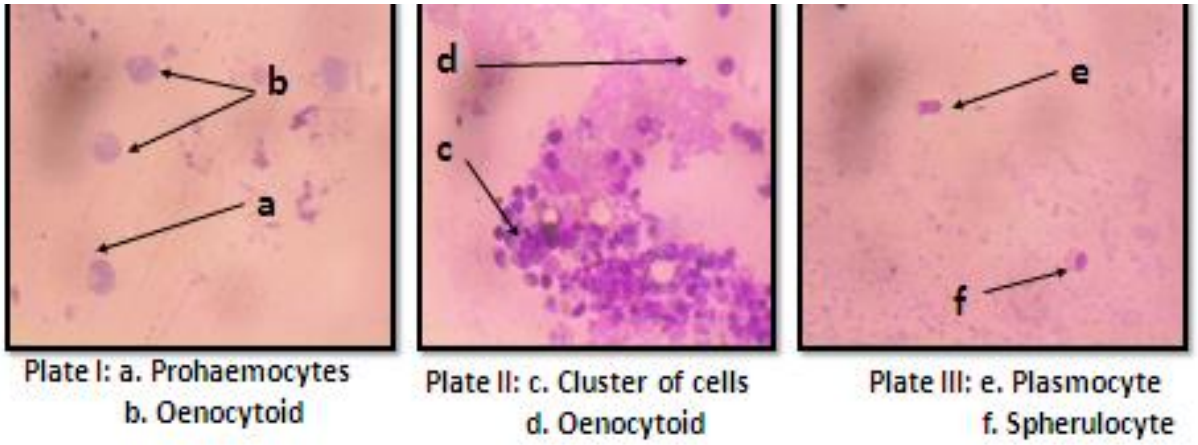

Fig.3. (Plate I; Plate II; Plate III): Different haemocytes in untreated cockroaches

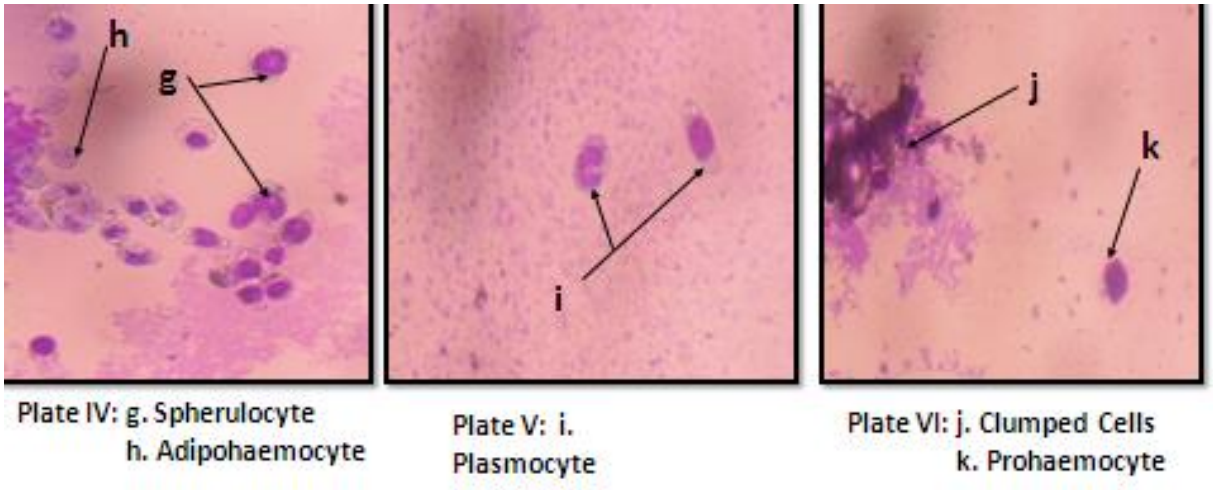

Fig 4. (Plate IV; Plate V; Plate VI): Different haemocytes in treated (0.008% Cypermethrin) cockroaches

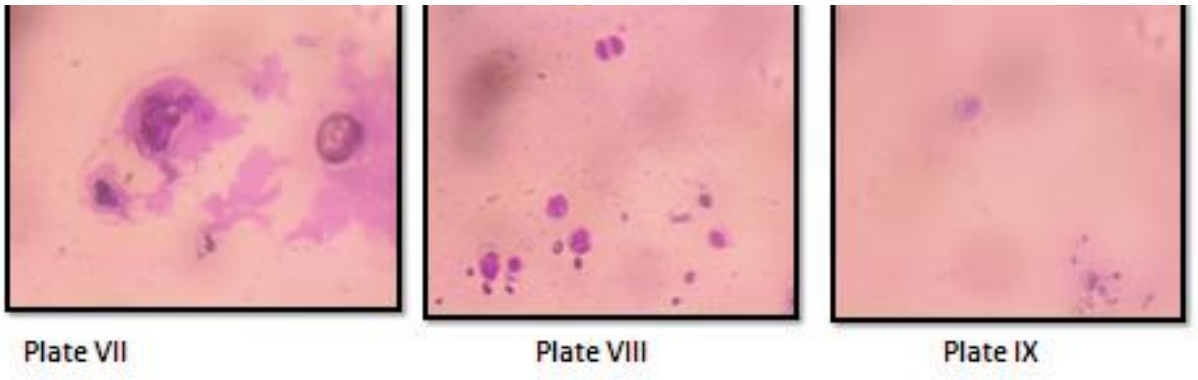

Fig 5 (Plate VII; Plate VIII; Plate XI): Different damaged haemocytes in treated (0.02% Cypermethrin) Cockroaches

Untreated cockroaches: The haemocytes were observed more in adult male cockroaches compared to that of female cockroaches. The highest number of haemocytes found in male cockroaches about 8760 cells per millimeter cube while the maximum number of haemocytes found in female cockroaches about 8560 cells per millimeter cube. The average numbers of haemocytes were observed in male 8384 cells/mm cube but in female the average haemocytes were 8152 cells/mm cube. These results differ from those of Pugazhvendan and Soundararajan (2012) who studied quantitative changes of Total Haemocytes Count during metamorphosis and reproduction in Hemipteran species.

Treated cockroaches: The effect of Cypermethrin (0.02% and 0.008%) after 24 hours exposure, on the blood cell count in haemolymph of the adult male and female *P. americana*, was greatly significant (Table 1). The highest number of blood cells observed and counted under microscope after the application of 0.008% Cypermethrin (10% EC) was significantly higher than the cells were counted after the application of 0.02% Cypermethrin (10% EC). The average number of blood cells counted under the microscope after the use of 0.008% insecticide was 7856 cells/mm cube in male whereas 7808 cells/mm cube in female which was significantly lower than the data obtained from untreated male and female cockroaches. It had been seen that the number of blood cells greatly reduced after the application of 0.02% Cypermethrin in female cockroaches, it greatly varied from 5840 to 6960 cells/mm cube than male which varied from 6440 to 6600 cells/mm cube on the haemolymph of adult *P. americana*. The similar trends were also observed by the findings of Kurt and Kayis (2015) who observed the effects of the pyrethroid insecticide Deltamethrin on the haemocytes of moth species. These results differed from those Al Hariri and Suhail (2000) who observed the

Table 1: Effect of Cypermethrin on the Total Haemocyte Count (THC) of adult *Periplaneta americana* after 24 hours exposure.

No. of Observations	Untreated Cockroaches		Treated Cockroaches with 0.008% Cypermethrin (10% EC)		Treated Cockroaches with 0.02% Cypermethrin (10% EC)	
	Male (Cells/mm cube)	Female (Cells/mm cube)	Male (Cells/mm cube)	Female (Cells/mm cube)	Male (Cells/mm cube)	Female (Cells/mm cube)
1.	8000	8560	8240	8200	6560	6000
2.	8400	8240	8040	7440	6600	6960
3.	8160	8320	7840	8240	6520	6200
4.	8760	7720	8160	7480	6440	6080
5.	8600	7920	7000	7680	6480	5840
Average	8384	8152	7856	7808	6520	6216

effect of Lambda Cyhalothrin and Deltamethrin on the Haemocytes of desert locust.

Differential Haemocyte Count (DHC)

Different haemocytes in untreated, treated (0.008% Cypermethrin) and different damaged haemocytes in treated (0.02% Cypermethrin) Cockroaches are shown in Figure 3, Figure 4 and Figure 5 respectively.

Untreated cockroaches

Differential Haemocyte Count in *P. americana* revealed highest percentage of Prohaemocytes (12.57%), followed by Oenocytoids (9.96%), Spherulocytes (8.84%) respectively. Adipohaemocytes (4.85%) were frequently observed in the blood smear of untreated cockroaches. Plasmocytes (3.73%) were also recognizable. Coagulocytes (2.86%) were least observable haemocyte in normal cockroaches.

Treated cockroaches (0.008% concentration of Cypermethrin)

There was an increase in the percentage of disintegrated haemocytes after 24 hours treatment of 0.008% concentration of Cypermethrin. Plasmocytes were increased to 4.48% compared to control 3.73%. Oenocytoids showed a reduction (7.34%) in their population as compared to the control set up 9.96%. Adipohaemocytes (5.35%) were frequently observed. Spherulocytes were also reduced to 5.23% compared to control 8.84%. Coagulocytes were scarcely visible under microscope. A huge change was observed in Prohaemocytes and their percentage was significantly decreased from 12.57% to 8.59% in the haemolymph of adult *P. americana* 24 hours post treatment of Cypermethrin.

Treated cockroaches (0.02% concentration of Cypermethrin)

After 24 hrs treatment of 0.02% concentration of Cypermethrin, Prohaemocytes were greatly affected and their percentage decreased to 6.22% as compared to control 12.57%. The Plasmocytes were severely affected cells and their wall was also ruptured due to the effect of insecticide. There was a minor change in Coagulocytes and their population was slightly decreased from 2.86% to 2.49%. The percentage of Oenocytoid (6.47%) showed a decrease with an increase in the concentration of insecticide, although they were distorted little bit. Spherulocytes showed a reduction (6.10%) in their number as compared to control set up (8.84%). Abnormal staining of haemocytes (i.e. changes in cell shape) was observed in the blood smear of *P. americana* treated with 0.02% Cypermethrin.

Insect is a favored model organism for such studies because of its short life cycle, larval size, ease of rearing, and ability to show results within days (Cook and Mc Arthur, 2013). Therefore, haemocytes (via changes in cell number and development of structural abnormalities) are frequently used to demonstrate the cytogenetic damage caused by toxic chemicals (Yeh et al., 2005). Circulating haemocytes perform several biological functions in insect body including transport and storage of nutrients, nodule formation, detoxification, wound healing, coagulation and plasma precipitation, heat transfer and protection. Cypermethrin caused significant changes to total and differential haemocyte count after 24 hours exposure. The number of blood cells counted under the microscope after the use of

0.008% and 0.02% of insecticides were significantly decreased in adult male and female cockroaches. It had been seen that the number of blood cells greatly reduced after the application of 0.02% Cypermethrin (10% EC) as compared to 0.008% on the haemolymph of adult *P. americana*. Several abnormalities such as distortion of nuclear membrane, changes in the cytoplasmic ratio, formation of vacuoles inside the haemocytes were also observed. Haemocytes in insect haemolymph have variable responses to different insecticides exposure. Increase or decrease in the percentage of haemocytes depends on toxicity of the insecticide, insect immune system and certain environmental factors.

Conclusion: Different types of haemocytes have important role in the protection of insects against invading pathogens and parasitoids. Cypermethrin is a synthetic, pyrethroid insecticide that is extremely effective against a wide range of insect pests. Cypermethrin acts as a contact poison as well as stomach poison in invertebrates. Cypermethrin exhibited the enormous changes to total and differential haemocyte count after 24 hours exposure. The average number of blood cells counted was higher in male as compared to female. It had been observed that the number of blood cells greatly reduced after the application of 0.02% Cypermethrin (10% EC) as compared to 0.008% on the haemolymph of adult cockroaches. Several abnormalities such as distortion of nuclear membrane, changes in the cytoplasmic ratio, formation of vacuoles inside the haemocytes were also observed.

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Prevalence of Paramphistomosis in and around Santiniketan, Birbhum, West Bengal

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Abstract: Paramphistomiasis causes enteritis and anaemia in ruminants and results in substantial production and economic losses. Pathological symptoms are produced by immature flukes. They start to gather in the intestine and cause disease. Immature paramphistomes are responsible for serious disease to their host, like profuse foetid diarrohea, anorexia, polydipsia, drop in plasma protein concentration and anaemia, which weaken the host. Diseases caused by the young flukes often results in high mortality, even upto 80-90% in ruminants. Flukes accumulate and attack the duodenal mucosa to induce acute enteritis. Liver tissues get damaged extensively leads to swelling, haemorrhage, discolouration, necrosis, bile duct hyperplasia and fibrosis. Mature paramphistomes are also responsible for rumenitis, irregular rumination, unthriftiness, lower nutrition conversion and loss of body condition resulting in considerable economic loss.

Ketwords: *Paramphistomum, livestock, paramphistomosis, ruminants*

Introduction: Livestock, an adjacent to agriculture, plays an important role in the future growth and development of Indian Economy. India has the largest livestock population which constitutes nearly 7% towards its national income where the cattle and buffaloes generate 54% of the energy for agricultural operations. Any effort to intensify livestock production has been seriously affected by various factors, of which the most serious losses are due to gastro-intestinal helminths. Goats are integral part of the livestock production system in crop – livestock mixed economy of the developing countries like India, but the benefits obtained from goats today do not match with their actual potential. Parasitic diseases contribute to the constraints of goat production.

Rumen flukes, also known as Paramphistomes, are parasites that infect ruminants including cattle, goat, sheep and water buffaloes. Paramphistomes are responsible for "Paramphistomosis" i.e., gastrointestinal parasitic disease characterized by lower nutrition conversion, decreased milk production and acute parasitic gastroenteritis with high morbidity and mortality rates particularly in domesticated and wild ruminants, which causes prime economic losses to the livestock industry to several thousand crores of rupees annually (Horak,1971). It has been a neglected trematode infectious disease in ruminants; but has recently come out as a significant cause of productivity loss in wool, meat and milk production. Distribution of paramphistomosis is worldwide, but the high prevalence has been accounted in tropical and subtropical regions, particularly in Africa, Asia, Australia and Eastern Europe (Nasmark, 1937).

Paramphistomes require an aquatic snail as an intermediate host and the pre-parasitic stages of the lifecycle (miracidia and stages in the snail). Rumen flukes, also known as paramphistomes, are parasites that infect ruminants including cattle, goats, sheep, and water buffaloes.*Paramphistomum*is considered to be one of the most important species of paramphistomes and are parasitic in the alimentary canal of many ruminants around the world. Mature parasites are especially prevalent in the reticulum and rumen, while immature parasites in the small intestine mainly in the duodenum (Eduardo, 1982b). Several species are also found in fish, amphibians, reptiles, birds and mammals. Immature flukes live in the small intestine and adults are found in the rumen or reticulum of ruminants, they have complex life cycle which requires an intermediate host for completion (Sey 1981-1982).

Immature migrating parasites of some species have been reported to cause serious disease and even deaths of their hosts by burying themselves into the sub-mucosa of the duodenum and feeding on the epithelial cells of the Brunner's gland which results in anorexia, polydipsia, profuse foetid diarrhoea, drop in plasma protein concentration and anaemia, which weaken the host. Mature paramphistomes are also responsible for rumenitis, irregular rumination, unthriftiness, lower nutrition conversion and loss of body condition (Urquhart G.M. et al. 1996).

Material and Methods: The present study was carried out in and around Santiniketan, Birbhum,West Bengal. The rumen and reticulum of slaughtered goat were collected every month from abattoirs to determine the seasonal prevalence of parasite and were checked for the presence of adult flukes. The adult flukes were carefully picked up with the help of forceps from rumen and reticulum of infected goat (Figure 1) and after collection parasites were washed properly with PBS (pH 7.4). Parasites collected from each animal were counted carefully to determine the intensity of infections. All examined goats belonged to *Capra hircus*.

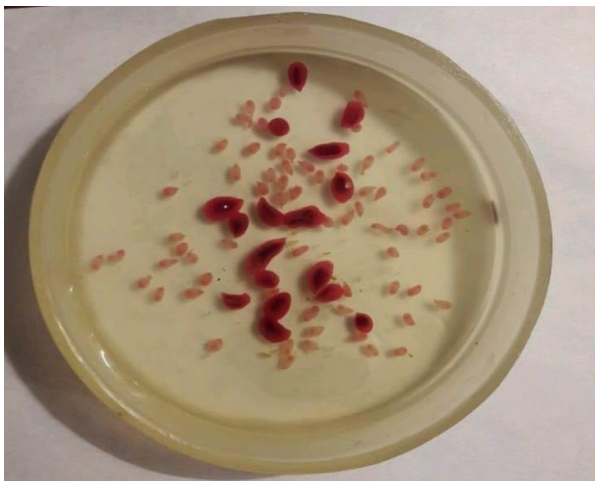

Figure 1: Parasites collected from infected goat

Result and discussion: Prevalence and distribution of species causing paramphistomosis show a wide variation with respect to geophaphical regions and host preference.

In the present study, paramphistomosis in goat was found throughout the year with prevalence between 2 % and 26 %, and with a yearly average of 13 %. The highest prevalence of *Paramphistomum* spp. in goat was observed in the summer (Figure 2).

In experiments it was evidenced that cattle were infected mainly throughout the rainy and windy seasons, during summer, autumn and at the beginning of winter Rangel-Ruiz et al. (2003). Outbreaks generally occur in drier months Soulsby (1982). Galdhar & Roy (2005) had reported a decreased prevalence in summer and increased prevalence during postmonsoon season in Chattisgarh, India. In different province of Turkey the prevalence of paramphistomosis in sheep ranged from 0.5 % to 100 % (Coskun, 1988; Tınar et al., 1992; Guralp, 1981; Gıcık et al., 2003). The highest infection in sheep was reported to be in summer and lowest in winter in the North West temperate Himalayan region of India (Tariq et al. 2008).

The intensity and severity of infection in the present study reaches to its maximum in late spring and summer. The lowest prevalence is in winter (November to January) with a mean prevalence rate of 2 % and the highest mean prevalence is during summer (March to June) with a mean prevalence rate of 26 % followed by a decreased prevalence in monsoon (July to September) and autumn (October) with percent prevalence of 11 and 10 respectively in goat (Figure 3). The low prevalence of paramphistomosis in winter season is likely to be associated with the nonavailability of intermediate snail hosts.

The age and sex had no significant influence on the prevalence of paramphistomosis (Godara et al., 2014). In this experiment samples were collected from male goats only. Infection was prominent in animals below 1 year of age and had a high prevalence rate than the animals between 1–3 years and above 3 years of age (Patel et al. ,2001; Tariq et al. 2008). In this study, infection was also noticeable in young goats compared to higher age groups. This higher rate of infection in lower age group animals may be attributed to low resistant due to low immunity and high susceptibility to infection. The adult animals gradually develop immunity upon reinfection with time and thus can avoid acute disease. While younger animals are pronwe to infection and develop acute disease (Horak 1971; Soulsby 1982).

In order to take control measures and determine the seasonal prevalence for paramphistomosis in the study area, further studies need to be done in other geographical regions to get a clear picture on the biology and behaviour of the parasites.

Acknowledgement: The author gratefully acknowledges the infrastructural facilities provided by the Principal, Bethune College and the laboratory facilities provided by Head, Department of Zoology, Bethune College for smooth running of the study. The author is also very thankful to Mr. Khairul for providing the samples and permitting access to the abattoirs

as and when required. Samples were collected from the goats slaughtered for consumption only.

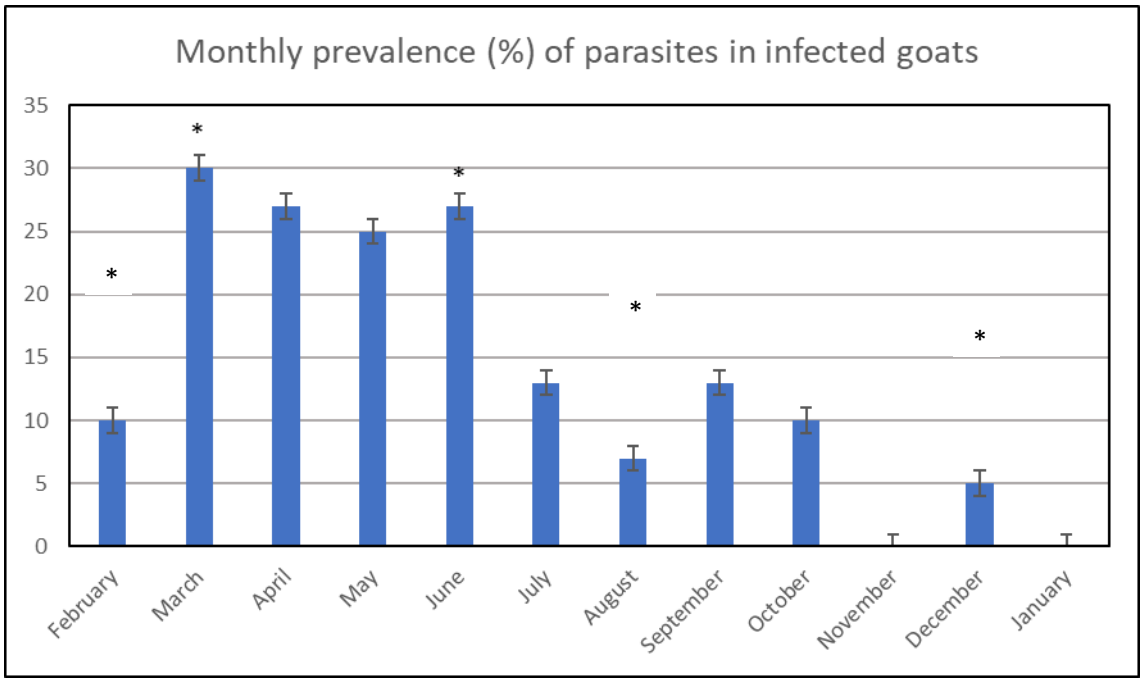

Figure 2: Monthly prevalence of *Paramphistomum* spp. according to gut examination in goat (asterisks indicate significant difference, $p<0.05$)

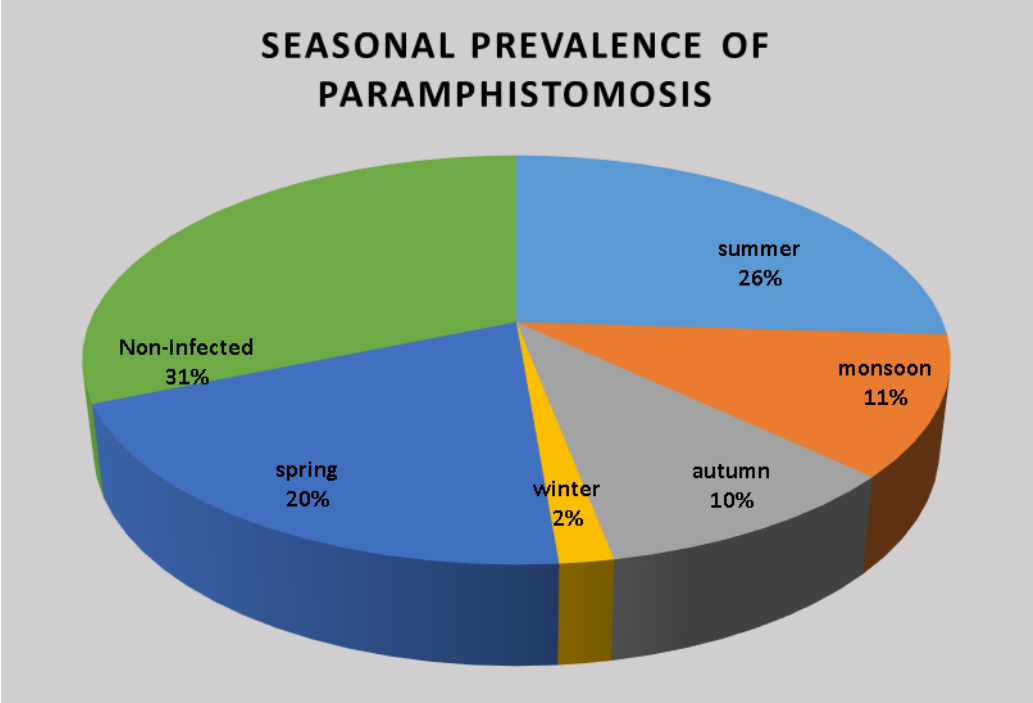

Figure 3: Seasonal prevalence of *Paramphistomum* spp. according to gut examination in goat

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Change in activity of Ornithine-Urea cycle enzymes in *Channa punctatus* under hyperammonia stress

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Abstract: In the present study, the apparent role of ureogenesis in preventing the accumulation of ammonia to a lethal level during hyperammonia stress in the environment was studied in the Indian freshwater air-breathing teleost, *Channa punctatus*, by exposing the fish to different ammonium chloride concentrations experimentally. On assaying two significant urea cycle enzymes, arginosuccinate lyase and arginase, it was observed that these two enzymes were significantly active in the synthesis of urea under hyperammonia stress. So, it was reasonable to predict that *Channa punctatus*, which is otherwise predominantly ammoniotelic, turned totally towards ureotelism to survive under these conditions by converting the high ammonia load into relatively less toxic urea. Thus, due to this unique physiological strategy of turning towards ureotelism from ammoniotelism via the induced urea cycle, this air-breathing teleost is able to survive in very high ambient ammonia conditions.

Keywords: *Ammoniotelism; ammonium chloride; hyper-ammonia stress; urea cycle; ureogenesis.*

Introduction: Nitrogen metabolism is considered as one of the most sensitive physiological systems showing adaptive changes in response to environmental variations. Accordingly, the nature of nitrogen excretory products in animals has changed with the evolution of vertebrates from water to the land habitat [1,2]. The major metabolic end-product produced during the breakdown of nitrogen-containing biomolecules found in various animal tissues is ammonia. The vast majority of the teleost fishes are ammoniotelic, excreting ammonia as the major nitrogenous end product in response to their aquatic habitat. However, under special circumstances, such as high ambient ammonia or aerial exposure, fish can hardly excrete ammonia and the toxic ammonia is concentrated in the blood and body tissues. In general, however, aquatic animals can tolerate more elevated levels of blood ammonia than terrestrial animals. Plasma total ammonia (NH_3+NH_4^+) normally remains between 0.05 and 2 mmol l^{-1} in most teleosts. However, blood ammonia levels greater than 0.05 mM can be toxic to the central nervous system of most mammals [3]. Ammonia is excreted directly if feasible or converted to some less toxic compounds such as urea, uric acid or amino acids in different animals.

Though majority of the teleosts are ammoniotelic, urea also constitutes 10-30% of the total nitrogenous wastes in most of them. The sources of urea and the presence of the ornithine-urea cycle in teleost are still under debate. However, the presence of a functional urea cycle which appears to be the major source of urea formation in higher vertebrates, has been reported in various teleosts such as *Oreochromis albalicus graham*, marine toadfishes *Opsanus tau* etc [4]. Air-breathing teleosts of the Indian subcontinent are unique among

freshwater teleosts in having a very active urea cycle, the capacity to switch from ammoniotelism to ureotelism under hyperammonia stress and during exposure to air, they have the capacity to tolerate very high ambient ammonia [5,6,7].

The Indian freshwater air-breathing teleost used in the present study is *Channa punctatus*, a facultative air breather usually inhabiting stagnant, slow flowing swampy water bodies or wetlands which are usually uninhabitable. When these swamps are covered with macro vegetation like water hyacinth it suffers from low dissolved oxygen and a pH range of 6.5-7.8 with more free carbon dioxide and high ammonia levels as a degradable product of micro and macro vegetation. During summer, when the swamps dry up, fish face more adverse ecological conditions and may burrow inside mud to avoid total dehydration.
The present study has been undertaken to find out the changes in the pattern of enzymatic activity of two of the five enzymes of the ornithine-urea cycle--- arginosuccinate lyase (ASL) used in the penultimate step catalysing the conversion of arginosucinate to arginine and fumarate; and arginase (ARG), the final enzyme converting arginine to ornithine and urea, under hyper-ammonia stress especially in the liver (most ureogenic tissue) and kidney of the much unexplored facultative air-breather *Channa punctatus*.

Materials and Methods

Animals *Channa punctatus* weighing (75±10)gm approximately irrespective of the sex were purchased from Maniktala market, Kolkata for the experiment. *Tubifex* was fed to the fishes and were kept in the laboratory tap water, which was changed regularly.
Experimental Protocol The experiment was conducted in 2 phases:
In the first phase 12 fishes of similar sizes(approximately 18 cm) were distributed equally in 3 aquarium trays containing 2 litres of 25mM, 50mM and 75mM NH_4Cl solution for about 30 days and another aquarium containing water as control. In the second phase 5 fishes were kept in 2 aquarium trays, 4 fishes in 75 mM NH_4Cl solution and 1 fish in water as control. The control fish was sacrificed on 0 day of exposure while the remaining 4 fishes were kept in 75 mM NH_4Cl solution and sacrificed only when they died due to ammonia toxicity.
Both the NH_4Cl solution and water was changed with a fresh medium everyday at a fixed time. The fishes were removed when they died, their lengths were measured and the liver and kidney tissues were dissected out, blotted dry and weighed.

Enzyme Assay 10% homogenate (w/v) of liver and kidney tissues of *C. punctatus* were prepared separately in 0.1% cetyltrimethyl ammonium bromide (CTB) for the assay of activities of ornithine-urea cycle enzymes, ASL and ARG. The homogenates were centrifuged at 600 r.p.m at -2˚C for 15 minutes. The supernatants were kept at -20 ˚C and later thawed for use in enzyme assay.

Chemicals All the chemicals including substrates (L-Arginine-CAS No.74-79-3; Arginino succinic acid-disodium salt hydrate- CAS No. A5707), CTAB (CAS No.57-09-0) were obtained from Sigma Chemical Co. and other chemicals were of analytical grades obtained from indigenous sources.

Results

Fig 1a-1d: Changes in activity of ASL and ARG in the liver and kidney of *C. punctatus* when exposed to different concentrations of NH_4Cl solution

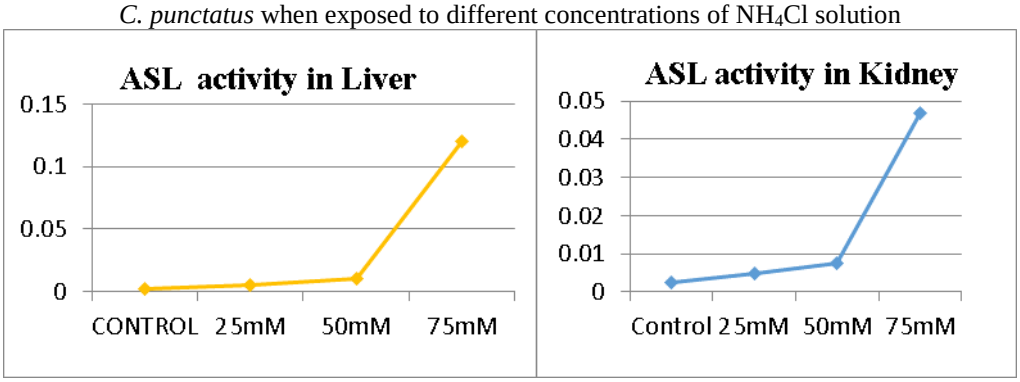

Fig 1a

Fig 1b

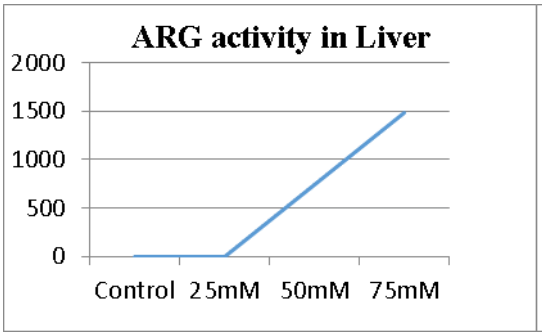

Fig 1c

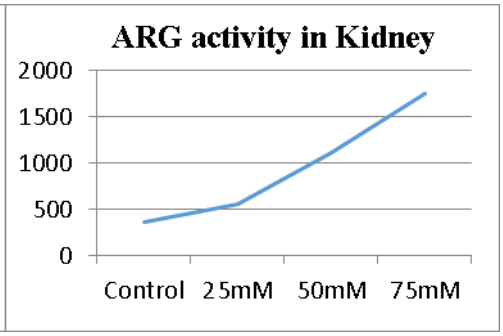

Fig 1d

Fig 2a-2d: Changes in activity of ASL and ARG in the liver and kidney of *C. punctatus* when exposed to 75mM NH_4Cl solution for 10 days.

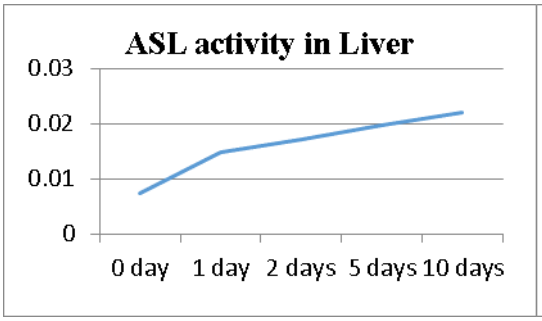

Fig 2a

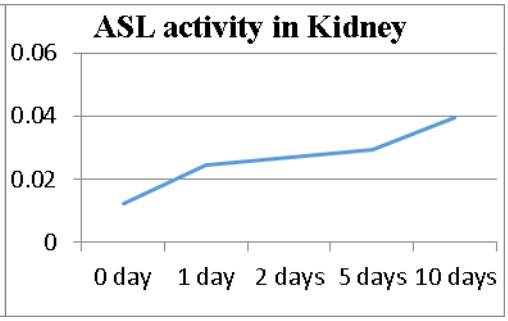

Fig 2b

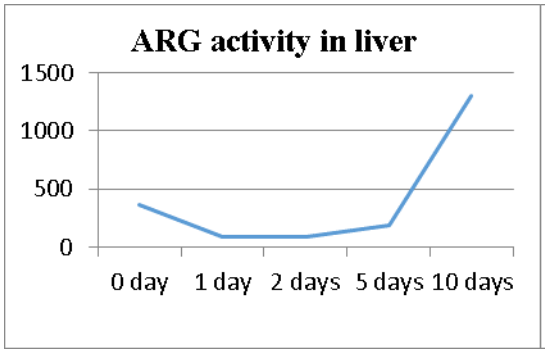

Fig 2c

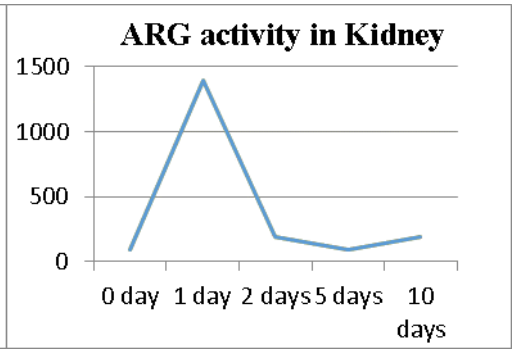

Fig 2d

Discussion and concluding remarks

The given study focuses on the adaptations that *C. punctatus* acquire with the aim of tolerating environmental constraints, particularly hyperammonia stress. One of the most attractive result obtained in this study is a sudden alteration in the activities of the urea cycle enzymes which is normally functional in the fish but at significantly lower levels. The activities of the two enzymes ASL and ARG were found to be considerably higher in the fishes exposed to hyperammonia stress, suggesting that a transition from ammoniotelism to ureotelism takes place to avoid any build up of ammonia in the body tissues of the fish to a toxic level. Most of the Indian air-breathing teleosts appear to have retained the genes for the urea cycle enzymes, since a full complement of urea cycle enzymes have been reported for many of them (Saha *et.al*. 1998).

For the fishes exposed to different concentrations of NH_4Cl (Table 1), the activity of ASL is found to increase with the concentration of NH_4Cl (Fig 1a, 1b). This is particularly due to the fact that as the concentration of NH_4Cl increases, a greater accumulation of ammonia takes place in the tissues which needs to be detoxified, triggering the need for ureotelism and consequent activation of the o-u cycle enzymes. However, in case of ARG, the change in the activity of the enzyme is quite unusual in both liver and kidney of *C. Punctatus* (Fig 1c, 1d). When assessing the enzymatic activity of the fishes exposed to 75mM NH_4Cl, (Table 2) it has been observed that as the number of days of exposure increases, ASL activity also increases proportionately in liver and to some extent in kidney (Fig 2a, 2b). However, the ARG activity shows alterations with increase in days of exposure to 75mM NH_4Cl, in both the tissues of the fish (Fig 2c, 2d). Overall, the ARG activity is found to be higher in the kidney than in the liver.

The accumulation of ammonia in different body tissues is accompanied with a significant stimulation of the activity of certain key enzymes of the urea cycle, such as ASL and ARG in both hepatic and extra-hepatic tissues of *C. punctatus*. The increase in activity of ASL with increase in both concentration of NH_4Cl exposure and days of exposure suggests that this increase might be a chronic adaptation for ammonia detoxification by elevating the rate of urea-nitrogen excretion via the induced urea cycle for the long-term maintenance of nitrogen waste excretion in the form of less toxic urea during exposure to high ambient ammonia (Saha *et.al.* 1998). However, it was observed that the activity of ARG did not increase proportionately with increase in concentration of NH_4Cl exposure or number of days of exposure. The conversion of some part of accumulated ammonia to various non-essential amino acids under high ammonia load (Saha *et. al*. 1999) may be one of the reasons for such anomaly. Initially at lower ammonia load, it is the induced urea cycle which is mainly responsible for the detoxification of ammonia while at a higher ammonia load, other detoxification pathways are also highly involved which may affect the activities of the o-u cycle enzymes. The conversion of accumulated ammonia to various non-essential free amino acids (FAA) is one such alternative pathway that has been reported in the mudskipper, *Periophthalmus cantonensis* (Iwata, 1988). Secondly, the accumulation of ammonia in the liver is a saturable process i.e. at higher rate of ammonia addition, the percentage uptake of

ammonia gradually decreases, which suggests that this low accumulation of ammonia may not serve as a strong modulator to induce the urea cycle. In addition, the physiological level of activity of ARG is quite high, and thus even the highest ammonia load in the tissues did not have any stimulatory effect on this enzyme of the urea cycle for enhanced ureogenesis. Ammonia also interferes with carbohydrate and fat metabolism and ATP levels, both in cerebral and extra cerebral tissues (Wiechetek *et.al.*1979). All these toxic effect of ammonia (both NH_3 and NH_4^-) may lead to convulsion, coma and eventually death.

Thus it appears that *C. punctatus* is capable of stimulating ureogenesis, by inducing the already existing functional urea cycle both in hepatic as well as some non-hepatic tissues, thus turning from ammoniotelism to ureotelism as one of the major physiological strategies to avoid the accumulation of toxic ammonia to a lethal level during exposure to higher ambient ammonia.

Acknowledgement

The present study supported by the Department of Zoology, Bethune College is gratefully acknowledged.

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Shrimp cultivation and the prospect of household earnings in a village of Sunderban

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Abstract Shrimp culture is the basic mode of domestic livelihood of the Mathbari village at Sandeshkhali block of Sunderban area. The Asian tiger shrimp (*Penaeus monodon*) is cultured in the bheris of Mathbari and other villages at Sandeshkhali. Almost, 80% of the entire landmass of Mathbari is devoted to aquaculture. The yield and the cost-effective assessment of shrimp cultivation in this area have never been evaluated before. Shrimp are popularly cultured in traditional methods and farmers either use their own small land area or pay leases to hire larger lands from other farmers for shrimp farming. This study shows that the owners' land and the leased land shrimp cultivation had average yields of 532.95 kg/ha/yr and 578.04 kg/ha/yr, respectively, during the year 2018. The owners' land and leased land farmers had net annual incomes of Rs. 176228/ha/yr and Rs. 114135/ha/yr, respectively. Strikingly, the farmers who cultivated shrimp in their own land apparently had more monetary profit relative to the leased land farming.

Keywords: *Asian tiger shrimp, Sandeshkhali, Mathbari, Shrimp culture, Bheri***.**

Introduction: The Sunderban is a well-known Biosphere Reserve and a heritage site located on the southern margin of West Bengal (Das et al., 2016), India. Sunderban is renowned for aquaculture due to its advantageous topographical factors and optimum natural conditions. This region has a huge potential for shrimp culture and supports domestic livelihood (Dubey et al., 2016), (Das et al., 2016), and earns foreign exchange. Shrimp farming methods are usually two types- traditional and intensive (Bhattacharya 2009). However, for any method, the practical know-how and technical insights among the farmers are important (Bhattacharya, 2010). The district, North 24 Pargana has 12 blocks – Barasat-ll, Deganga, Rajarhat, Baduria, Haroa, Minakhan, Hasnabad, Hingalgunj, Sandeshkhali-l, Sandeshkhali-ii, Basirhat-l, and Basirhat-ll. These blocks have been further divided into small villages. The total area of Sandeshkhali-l (lat. The 22.4379 ° N, long and 88.8495° E) block is 18217 ha and shrimp cultivation occurs in 5537 ha area which is 30% of the size of the total area of the Sandeshkhali-l block (Fig.1-A, B, and C). The total numbers of villages present in Sandeshkhali-l are thirty. A village named Mathbari Abad from this block has been taken as a "model village" for this present work done during 2018-2019. The total area of Mathbari Abad is 767 ha (lat. 22.477°N, long and 88.761°E). Like other villages, shrimp is cultivated in small water bodies or local fisheries called 'Bheri' or 'Gheri' in this village. These Bheris get their water from the nearby rivers, canals, or lakes via channels and are regulated by sluice gates or pillars made up of Bamboo. The main species cultivated in this bheri are Giant tiger prawns or Asian tiger shrimp (*Penaeus monodon*) **(Fig 2. E)**. These decapod crustaceans

have stalked eyes, long narrow muscular tails, whiskers, and slender legs. They are rich dietary protein sources hence are economically very important. Shrimps also provide important food resources for tilapia, bhetki, and crabs, etc. in the ecosystem. This manuscript encompasses the shrimp culture method and domestic income in Mathbari village located at Sandeshkhali-1 (Fig1), Sunderbans. All the farmers at Sandeshkhali-1 block prepare bheris by following methods like dewatering, drying, liming and demolishing predators, etc. The water before discharging in the bheri is filtered by a bamboo screen. Generally, a bheri is 2.5-3.5 feet deep. The natural algal growth in the bheri provides excellent food resources for the shrimps and in the traditional system of shrimp farming, no dietary supplements are needed. The shrimp eggs are collected from hatcheries and harvested using bamboo cages called the 'Atol' or by cast netting. The harvesting period starts from January to November. The yielded shrimps are collected 3-4 times within this period. A huge amount of shrimps are cultivated yearly in these bheris and it is much profitable business for domestic livelihood among local people. So, it can be easily understood that the main occupation of the villagers is "shrimp cultivation".

Materials & Methods

Study Area: Mathbari Abad is situated along a branch of the river Bidyadhari. This village is demarcated by the river towards the north and the villages of 'Dheknamari' and 'Petua Dhanihati' are located towards the south. The village of 'Khariat' Abad is located towards the east and the 'Minakhan' block towards the west. On the west and east, the village has two branches of river Bidyadhari, namely 'Khariatkhal' & 'Dheknamarikhal' respectively. Approximately, 614 ha area of the village is dedicated to the fishery (Gram Panchayet database). A large percentage of conversion of arable lands into bheris is found here being encouraged mainly by the supply of saline tidal water from the branches of the river Bidyadhari. According to satellite images available on Mathbari Abad, the approximately whole village appears as a common widespread brackish-bheri.

Process of field survey: Primary data were collected by field survey. This survey included the study of the areas and methods for shrimp production, the annual yield of shrimp, net monetary gain, and domestic livelihood (Joffre and Schmitt, 2010). This survey was conducted in the context of questionnaire interviews with farmers and the responses were cross-checked with key information gathered from technically efficient farmers. Data were collected for seven months from October, 2018 to April 2019.

Interviews with Scientific Questionnaire: Prior to interviews, a scientific questionnaire was prepared in such a way, that maximum features of shrimp farming were included (Dubey et al., 2016), (Rahman et al., 2013) The questionnaire was originally written in English, and then translated into Bengali (local language) to obtain effective survey results. The questionnaire was conducted with 15 farmers.

Cross-checking of survey information and land usage from Gram Panchayet (Village administrative body): The responses of farmers were further verified using the key information. This key information had been provided by farmers with specialized knowledge on shrimp culture with at least twenty years of experience in shrimp culture practices and the information of the functional distribution of area was gathered from Gram Panchayet office, which is situated at Boyermari-I and block fishery office under Nazat, Sandeshkhali-I.

Statistics: Mean of at least five field surveys was taken for calculating ± s.d. Pair wise t-test was done to check the significance.

Results

Functional distribution of study area as per Gram Panchayet database: As per the Gram Panchayat database, the land use pattern is as follows. i.e. Mathbari village is 4% of the total Sandeshkhali block. The Area dedicated to the fishery in Mathbari with respect to the total area of Mathbari is 80%. The area for the human dwelling is approximately only 12% of the total area of Mathbari. Finally, 8% of the area is used for maintenance land or called 'Aal' in the local language. This data of functional distribution of area in Mathbari has been provided by Gram Panchayet office and depicted below:

Place	Area in ha
Area of Sandeshkhali	18217
Area of Mathbari village	767
The total area used for fishery	614
The total area used for human dwelling	92
The total area used for barrier (maintenance land)	61

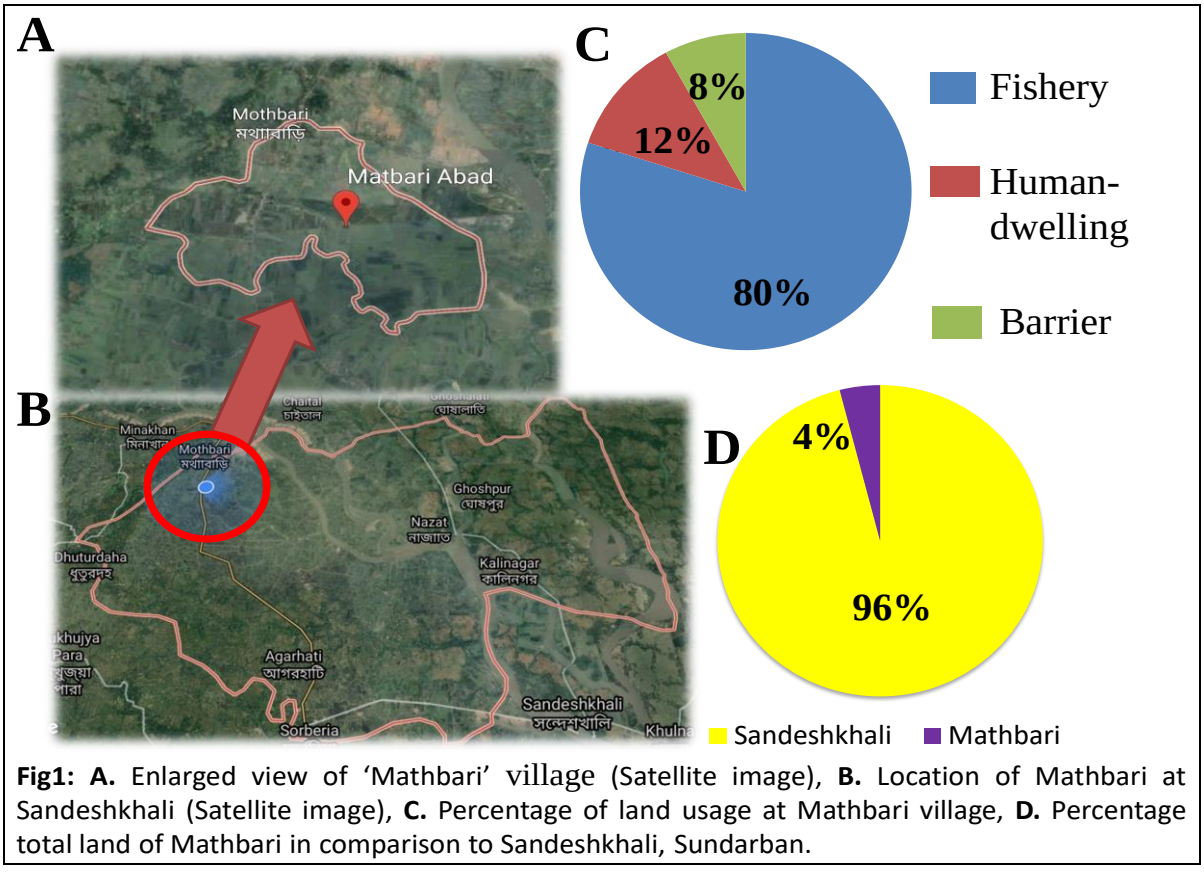


Fig1: A. Enlarged view of 'Mathbari' village (Satellite image), **B.** Location of Mathbari at Sandeshkhali (Satellite image), **C.** Percentage of land usage at Mathbari village, **D.** Percentage total land of Mathbari in comparison to Sandeshkhali, Sundarban.

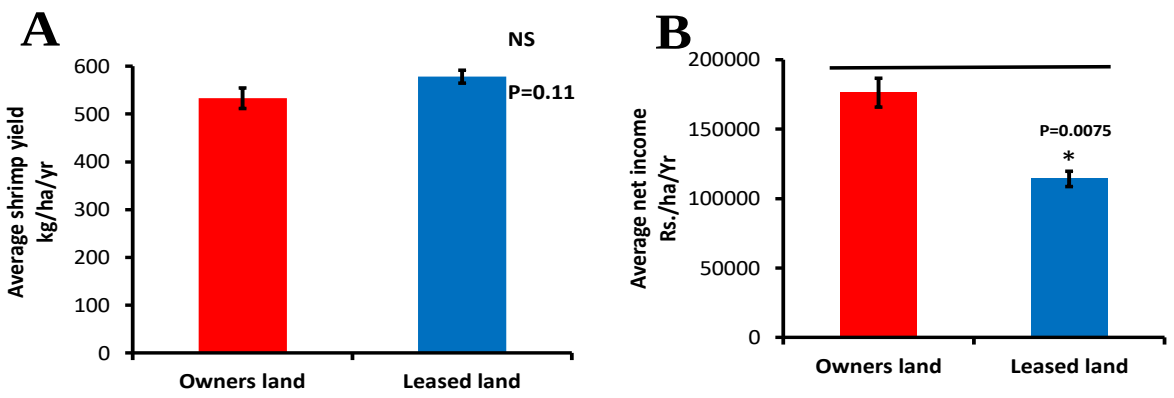
value of shrimp is generally 450/- per kg, though it may vary yearly. The average yearly net earnings were comparable. Apparently from Fig 3A, it is notable that yield did not significantly vary when cultivated in owners land or leased land but the annual average net earnings were more in owners land w.r.t. leased land (Fig. 3B).

Fig 2: A. Bheri or Gheri (photo taken at Mathbari, Mahatopara), **B.** Natural growth of algae in the bheri (Photo captured at Mahatopara), **C.** 'Atol' (Photo captured at Mathbari), **D.** Man working on Atol, **E.** Shrimp captured on net (Location Mathbari)

Statistics Data were shown as mean +/- standard error. All statistical analysis (t-test) and graphs were prepared with Microsoft Excel software. *p-value <0.05 was considered as a significant difference.

Discussion: This is a survey-based study to understand the current status of shrimp culture and household earnings in a model village called Mathbari. Following were the findings and interpretations. Mathbari is a small portion of Sandeshkhali and blessed with convenient environmental factors for shrimp culture. Therefore, shrimp culture is the most common mode of earnings in families. Some amount of land is used as maintenance land and human dwelling. Here, two popular methods of shrimp cultivation are seen, one is cultivation at own land, another one is cultivation at others land with the lease. The annual net monetary gain in shrimp culture was more in owners land w.r.t. lease method as evident from Fig.3 and table below Fig.3 **(**for owner's land and leased land the net annual income were Rs 176228/- and

114135/- /ha/yr respectively); though, the yield of shrimp per ha in both the cases did not vary significantly i.e. 532.95 kg/ha/yr and 578.04 kg/ha/yr respectively. It is to be mentioned that when yield becomes more, the average annual net monetary gain exceeds and becomes profitable many folds in leased land with respect to the owner's land. Strikingly, the farmers who cultivate shrimp in their own land apparently have more monetary gain suggesting that shrimp culturing may be a cost effective alternative even for the small farmers.



Shrimp culture	Average shrimp yield in kg/ha/yr	Average net income in Rs/ha/yr
Owners land	532.95±21.5	176228.4±10402
Leased land	578.0544±13.5	114135.8±5504

Fig3: A. Average shrimp yield in kg /ha/yr at owners land and leased land, P value is (> 0.05) is not statistically significant (NS) for t-test **B.** Average net monetary gain in Rs from shrimp culture, P value is statistically significant (< 0.05) for t test. Values represent average ± s.d., n = not less than 5. These statistics are the result of work done during 2018-19

Conclusion: Mathbari and the entire Sunderban area are more or less dependent on shrimp culture, The annual net income from shrimp culture is more when cultivated in own land than leased land though the annual yield of shrimp does not significantly vary. The farmers who hire land for shrimp culture generally take large land areas for the purpose and yield more crops compared to those farmers who culture shrimp at their small-sized lands owned by them. Apparently, the shrimp yield is more in leased land in comparison to owners' land, but owners don't have to pay leases; this adds to their net monetary gain contrary to the farmers who cultivate shrimp in leased land and have to pay a large amount of lease. However, practically if at any year the annual yield of shrimp becomes very high, the leased land farmers will get a huge advantage by supersiting owners with respect to net monetary gain. This has been mentioned by experienced farmers. The future direction may be the incorporation of scientific as well as sustainable methods to increase effective and sustainable shrimp yield more than the present. Also, the authors intend to study year-wise yield and net monetary gain in shrimp culture in Mathbari village for future.

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Ammonia induced Astrocyte swelling in *Channa punctatus*

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Abstract: Air breathing ammonotelic teleost of the Indian subcontinent is unique among fresh water teleost. They have active urea cycle and have the capacity to switch ureotelism under hyperamonia stress. Glutamate synthetase located in the astrocyte, usually detoxify ammonia through binding with glutamate to glutamine. During elevated expression of glutamate synthetase, astrocyte undergoes morphological changes initiating astrocyte swelling. *Channa punctatus* has both ammonia and urea as excretory product. But hyperamonia state induces astrocyte swelling in brain. *Channa punctatus* can be utilized as an unique model for hyperamonia induced astrocyte swelling.

Key Words: *Ammonotelic, Ureotelic, Hyper ammonia, Astrocyte, Teleost*

Most teleost fish are ammonotelic (Campbell *et.al*.1991; Randell *et.al*.1989; Watton *et.al*.1977). Air breathing teleost of the Indian subcontinent are unique among fresh water teleost because they have active urea cycle and have the capacity to switch ureotelism under hyper ammonia stress and during exposure to air (Saha et. al.1995;Saha & Ratha, 1987; Saha & Ratha,1989). *Channa punctatus* are one of the air breathing teelost predominantly found in stagnant or slow flowing water, swampy water bodies and also in wet land. In catfish (*Heteropneustes fossilis*) and walking Cat fish (*Clarias batrachus*), extreme tolerance to very high concentration of ammonium chloride (up to 50-75mm) was reported (Saha and Ratha,1990; Saha and Ratha,1994; Saha and Ratha ,1998).

Brain function during extreme ammonia stress is an important aspect to study among freshwater air breathing teleosts of Indian subcontinent. Glutamate synthetase located in the astrocyte, usually detoxify ammonia through binding with glutamate to glutamine (Smith and Weil-Malherbe, 1962). During elevated expression of glutamate synthetase, astrocyte undergoes morphological changes initiating astrocyte swelling. Even in astrocyte cultures glutamate incorporation induces a rapid increase in volume of astrocyte (Koyama et.al. 2000). Glutamate glutamine cycle was disturbed during hyperamonia, activation of Glutamate Synthetase was mediated for astrocytic protection against glutamate. It is clear that neurons depend on astrocytes for protection against glutamate toxicity.

Hyperamonia can be experimentally induced in vitro by different methods, like ammonium acetate injection (Boyano et.al.1992; Kosenko et. al.1999, Kosenko et. al.2000), ammonia treatment of cultured astrocyte (Norenberg et. al.1979; Norenberg, 2005; Wanienski, 1992), ammonia enriched diet (Felipo and Butterworth, 2002, Bodegra et. al 1991) or exposure to hyperamonia water using ammonium acetate (Levi et. al. 1974). In *Channa punctatus* both ammonia and urea were produced and urea cycle enzymes were active (Kumar et. al.2012). The aim of the present study was to induce hyperamonia in *Channa punctatus* to characterize the effect on astrocytes in brain.

Materials and Methods: *Channa punctatus* weighing 80±20g were purchased from the local market of Kolkata,India and acclimatized in the laboratory for a week at constant room temperature 30±5˚C in 12h:12h light and dark period before experimentation. *Tubifex* was given as food. Water in the aquarium was changed every day.

Experimental protocol: 15 fishes of similar size were distributed equally in three aquariums of which two containing 10 and 35mM ammonium chloride respectively and rest one was as control. The fish was removed as soon as it was died. Brain was collected from live fishes after sacrifice and also died one. Immediately formalin fixation was done and processed for micro-techniques. 5µm thin sections ware stained following standard haematoxylin-eosin staining and observed under microscope and image was captured in Magnus pro Software.

Observations: At low dose (10mM) of ammonium chloride less swelling of astrocytes (Plate 1A and 1B) was observed than higher dose (35mM). Similar change was not observed in control specimen (Plate 1C).

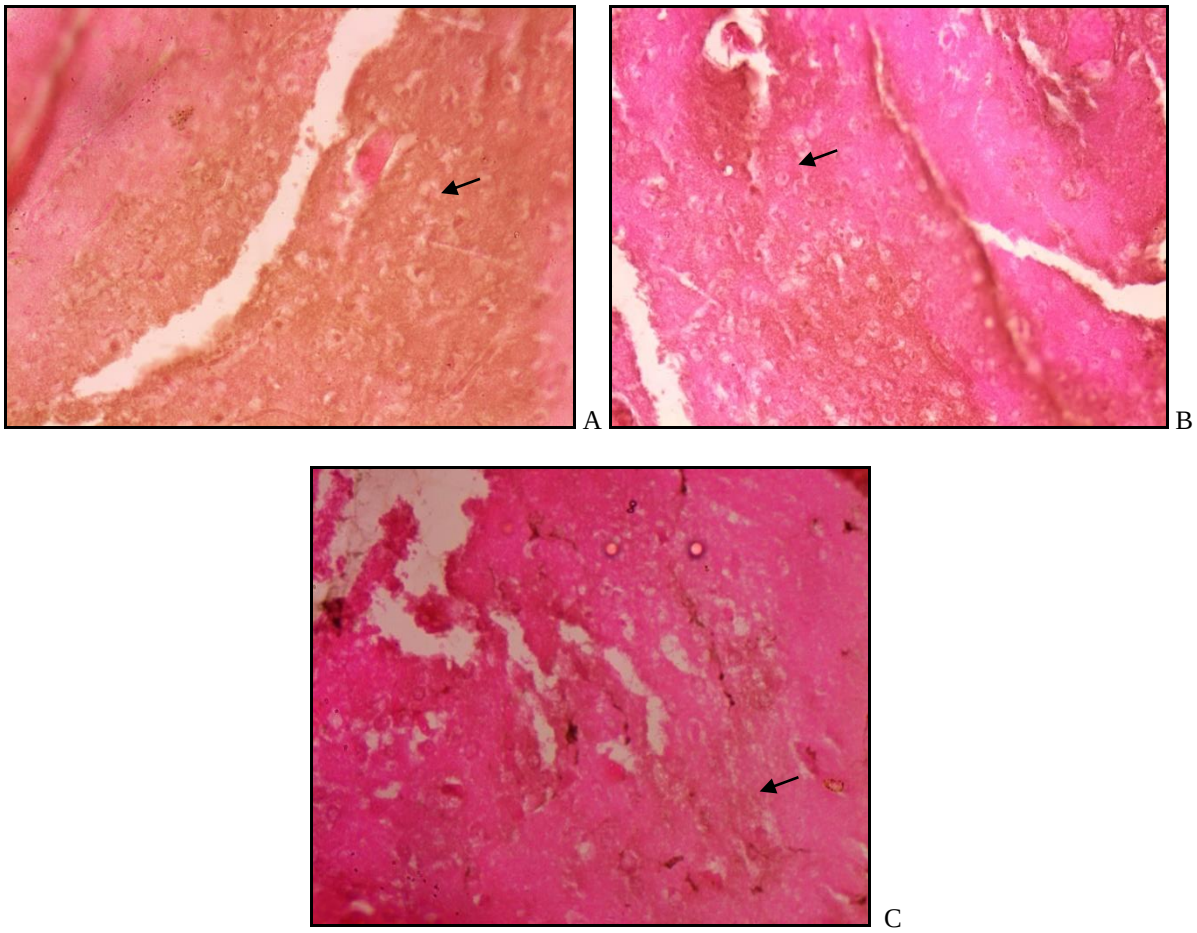

PLATE 1- Showing histological sections of the brain of *Channa punctatus* after exposure of (A)10mM ammonium chloride(low level of astrocyte hypertrophy) (B)35mM ammonium chloride(increased level of astrocyte hypertrophy) and (C) in normal water (No such hypertrophy in astrocytes).

Discussions: During hyperamonia, astrocyte swelling with ammonia metabolism and glutamine synthesis develop glutamine/osmolyte hypothesis (Zwingmann et. al. 2000).

Jaykumar et.al. 2006 proposed that glutamine mediated oxidative stress and/or mitochondrial permeability transition may cause astrocyte swelling. Ip and Chew, 2010 structured a hypothetical scheme for ammonia induced astrocyte swelling describing following steps, a) Amonia and ammonium both permeated through blood brain barrier, with or without the aid of transport protein, b)ammonium ion and glutamate form glutamine in presence of glutamate synthetase, c) Glutamate entered into mitochondria, d) ammonium released from glutamine in the mitochondrial matrix, e) the then reactive oxygen species production was increased, f) Mitochondrial permeability transition was induced, g)oxidative stress was developed in the cell and h)activation of aquaporin channels , influx water in cell resulting swelling as well as astroglial dysfunction. Mitochondrial permeability transition is calcium dependent and cyclosporine A sensitive process. Agents to block mitochondrial permeability transition were significantly reduced during ammonia induced cell swelling (Reddy et.al. 2009). *Channa punctatus* is unique for both ammonotelic and ureotelic nature and did not show any seasonal fluctuation (Roy and Das,1989). In the present study ammonia induce astrocyte swelling (Plate 1A and 1B). Development of astrocyte swelling in *Channa punctatus* can be further utilized for suitable astrocyte hypertrophy- model development.

The astrocyte cell membrane has higher permeability for ammonium ions. Extra cellular spaces were reduced (Sykova1999; Nicholeon and Sykova, 1998). It was also reported that increased glutamate release may cause swelling (Keinelloberg and Ramson,1986; Keinelloberg et al, 1990; Hanson et.al.1994, Sykova 1999).Increase in ammonia in brain induce glutamate synt hetase activity to metabolize excess ammonia and glutamate.

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