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It should contain the following information :

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Methods : The methodology, apparatus and procedure in sufficient detail should be identified to allow other workers to repeat the experiments. Standard methods can, however, be identified by proper references. The new or substantially modified methods should be described giving reasons for using them.

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Regulation Of Interleukin-8 Receptor Expression In Human Neutrophils–A Strategy Undertaken For Controlling Inflammation

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Abstract

Neutrophils provide a first line of defence against bacterial and fungal infection. In a number of inflammatory diseases, neutrophils are excessively accumulated, cluster together, release several toxic oxygen radicals, proteolytic enzymes which lead to damage of the host tissues and cause pathogenesis of a large number of diseases. Interleukin-8, neutrophil chemotactic agent, is known to be the key mediator of a large number of "neutrophil driven" inflammatory diseases. Since the cytokine exerts its actions on the target cells through a cell surface receptor, study of the regulation of receptor expression on the target cells seems to be very important. Here, efforts for exploring the regulation of receptor expression using several immunomodulators have been described. Knowledge about the regulation of IL-8 receptor expression may direct modulation of the functions of neutrophils so that their deleterious effects may be transformed to beneficial ones for the host.

Key Word : Inflammation, Interleukin-8, Neutrophils, Regulation of IL-8 receptor expression.

Introduction

Accumulation of leukocytes is vital for many immunologically mediated reactions as well as for wound healing. Polymorphonuclear neutrophil, a major participant in host defence and wandering phagocytic white blood cells primarily provides a first line of defence against invading microorganisms like bacteria , fungus etc. Neutrophils are suitably equipped to seek out, ingest and destroy most foreign invaders with the help of powerful oxidative respiratory burst response generating toxic oxygen radicals-e.g. singlet oxygen (I_{O2}), superoxide anions (O_2), hydroxyl radicals (OH) and hydrogen peroxide (H_2O_2). Neutrophils not only kill the microorganisms but also attack tumors and parasites (1-4).

Although neutrophils provide a principal means of defence against bacterial and fungal infections, they can also be destructive to host tissues. The same oxidative and nonoxidative process that was so important in killing microorganisms causes pathogenesis of a large number of noninfectious disease processes. The common feature of these diseases are–neutrophils migrate excessively towards the sites of infection, the cells aggregate, release several mediators, toxic oxygen radicals, proteolytic enzymes damage host tissues and augment the inflammatory symptoms, enhance tissue injury and may prevent healing.

From this study it is indicated that there is involvement of chemotactic agent(s) in the regulation

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of neutrophil activities. There are several biological substances which have been reported over the years to act as chemoattractants for neutrophils. A few of them have been thoroughly investigated. These include formyl-methionine-leucyl-phenlalanine (tripeptide), complement 5a (C5a), platelet activating factor (PAF), leukotrien B4 (LTB4) etc (5,6).

Interleukin-8

After identification and characterization of a cytokine- interleukin-8, (IL-8), a potent neutrophil chemotactic agent from lipopolysaccharide stimulated human monocytes, the possibility for investigation of the mechanism of accumulation of neutrophils has been reopened from a new angle. The mature form of IL-8 consists of 72 amino acids having M.W. 8 kDa. Based on amino acid sequence similarities, IL-8 has been grouped into a superfamily of ten or more proinflammatory cytokines that has been divided into C-C and C-X-C subfamilies according to the spacing of conserved cysteine residues in the primary amino acid sequences. Members of the C-C family that have been identified include MIP-1, MIP-1B, MCAF and RANTES. The members of the C-X-C family include IL-8, MGSA/GRO, platelet factor 4 and B thromoboglobulin. The 72 amino acid long chain is derived from a 99 amino acid precursor. The cytokine not only induces the accumulation of human neutrophils but also activates neutrophils by triggering respiratory burst response which induces release of toxic oxygen radicals and lysosomal enzymes. It has recently been shown to cause PMN shape change and to upregulate the expression of a variety of adhesion molecules (CD 11b/c Di8, CD11c/CD18) that mediate interaction of neutrophils with endothelial cells (7-9). Considerable amount of IL-8 either in peptide form or in active mRNA has been detected in the inflamed tissues of a large number of acute and chronic inflammatory diseases like psoriasis, rheumatoid arthritis, adult respiratory distress syndrome, asthma, contact eczema etc. as mentioned in Table-1. It suggests that IL-8 is involved in the augmentation of inflammatory responses. As IL-8 is implicated in the pathogenesis of a large number of neutrophil driven inflammatory diseases the mode of chemoattraction of PMNs from peripheral blood stream to the site of inflammation needs to be clarified in details. Thus, information relating to the mechanism of accumulation of inflammatory cells to the damaged tissue may provide clues for developing more rational forms of therapy (10,11).

Table–1

INTERLEUK IN–8 MEDIATED INFLAMMATORY DISEASES

Joint Diseases	:	Rheumatoid arthritis, Gouty arthritis
Skin Diseases	:	Psoriasis, Contact eczema, Atopic dermatitis, pulmoplantar pustulosis
Respitory Diseases	:	Adult respiratory distress Syndrome (ARDS)
	:	Asthma, Cystic Fibrosis, Chronic Bronchitis, Idiopathic pulmonary fibrosis, Pleural emphysema, Allergic asthma.
Gastrointestinal Diseases	:	*Helicobacter pylori* infection (Gastritis) Ulcer-ative colitis, Inflammatory bowel diseases
Renal Diseases	:	Urinary tract infection, Proliferative glomerulonephritis, Bladder inflammation.
Others	:	Meningitis, Cystic fibrosis, Uveitis, Mammary carcinoma. .

REGULATION OF IL-8 RECEPTOR EXPRESSION

IL-8 Receptor : The directional migration of neutrophils in response to very low amount of IL-8 suggested the presence of specific plasma membrane receptor on the surface of neutrophils through which IL-8 exerts its effects. The availability of a large amount of pure active recombinant IL-8 has permitted us to examine whether neutrophils express specific cell surface receptors for IL-8. By radiolabelling IL-8, with monoiodianted Bolton-Hunter reagent at 4° C the specific binding of ^{125}I IL-8 to the surface of human neutrophil was observed. Excess amount of non-radioactive IL-8 was able to inhibit the binding by 95%. We also established that IL-8 receptor was distinct from the receptor of other cytokines and chemoattractants of neutrophils. We reported from Scatchard analysis that 20,000 high affinity receptors are present per neutrophil (kD x 10^{-10} M). We further characterized, by cross linking experiment, two types of IL-8 receptors in human neutrophils having mol. wt. 59 KD and 67 KD respectively (12-14).

IL-8 can rapidly downregulate its own receptor at 37°C. About 90% of the cell surface receptor was downregulated within 10 mins of incubation. This downregulation was associated with the internalization of the ligand. The internalized ligand was degraded by the proteolytic enzymes and the receptor was recycled to the surface of the cell after 20 mins. Thus, a continuous recycling of the receptors is associated with the IL-8 induced migration of neutrophils (15, 16).

A cDNA clone encloding the receptor for IL-8 receptor has been isolated from human neutrophils by expression cloning. Mammalian cells transfected with IL-8 receptor cDNA clone bind IL-8 with high affinity. The amino acid sequence encoded by the clone shows that the receptor for IL-8 belongs to the superfamily of G protein-linked receptors that contain seven transmembrane domains. (8,17,18).

Recently, it has been reported that Glu-275 and Arg 280 of the extracellular loops 3 of the receptor lie in close proximity to one another and constitute a major binding domain with the N-terminal region for IL-8 (19, 20). In order to understand the ligand-receptor interaction and modulation of receptor, detailed information about the IL-8 binding site is required. Using thiol group specific modifying reagents N-ethylmaleimide and diamide and reversing the modification by dithiothreitol (DTT), we have demonstrated that at least two sterically close sulfhydryl groups are located in the binding domain of IL-8 in the receptor (21, 22). The cysteine residues of the N-terminal region (cyc-30) and loop-3 (cys-277) may interact with one another forming a disulfide bridge which may be an important determinant of receptor-ligand interaction (23).

Regulation of receptor expression :

Since expression of functionally active cell surface receptor for IL-8 determines the extent of interaction as well as stimulatory effect of the cytokine on the target cell, information about the regulation of receptor expression under normal and pathological conditions is very important.

To study the regulation of receptor expression on the surface of neutrophils- the effect of cytokines, interleukins, mitogens, lectins, steroidal and nonsteroidal anti-inflammatory agents need to be investigated in details. From this study it would be realized whether a common regulatory mechanism for receptor expression or different regulatory mechanisms come into play in presence of different immunodulators. From the results an idea about the regulation of the functions of IL-8 under different conditions can be envisaged. This may provide valueable information for understanding the IL-8 directed migration of neutrophils.

Effect of fMLP and LPS:

The bacterial products - formyl peptide (fmLP) and serum activated LPS could upregulate IL-8 receptor by 54% and 120% over the control through degranulation process of secretary vasicles and *de novo* protein synthesis respectively. It was observed that LPS binds to a serum protein liopolysaccharide-binding protein (LBP) and form LBP-LPS complex which stimulates neutrophil through CD-14, a LPS receptor expressed on the surface of neutrophils. The LPS (Ser. act) stimulated cells migrated faster towards IL-8 with respect to control suggesting some potential role of neutrophils in the host defensive mechanism during bacterial infection (24).

The LPS (Ser. act) stimulated induction of IL-8R level came down to normal level within 2h of LPS stimulation by the activation of a Ca^{++}-dependent aminopeptidase which cleaved the extracellularly exposed -NH_2 terminal end of the IL-8. Since the free NH_2 group is critical for binding of IL-8 to the receptor, the cleavage of the amino groups turns the receptor to nonfunctional state. This is a unique process which limits the amplified biological response of LPS stimulated cells and controls the IL-8 mediated functions of the neutrophils. The up and subsequent downregulation of IL-8R studied *in vitro* is a unique autoregulatory mechanism which may have some potential role *in vivo* during interaction of LPS with neutrophils. In many diseases, aminopeptidases are not functionally active. Since the aminopeptidases are known to play "house keeping" functions in cells, the upregulated IL-8 receptor could be correlated with the impaired activity of the aminopeptidase in these diseases.

Effect of polyene antibiotics :

Polyene antibiotics- amphotericin B nystatin (mycostatin) and hamycin, the antifungal agents, at the subtoxic doses, were able to reduce IL-8 induced chemotaxix as well as binding of ^{125}I IL-8 to the cell surface receptor by 70-80%. The loss of IL-8 binding to the cell was concommitant with the significant reduction of the IL-8 induced intracellural Ca^{++} -release. Hamycin, an extremely potent but less toxic antibiotic as compared to amphatericin-B, inhibited IL-8 binding and IL-8 mediated chemotaxis of neutrophils in Boyden chamber by 65% and 85% at the dose of 4 ug and 8 ug/ml. From the NBT test and ^{14}C-glucose uptake it was observed that general metabolic process of hamycin treated cells was not significantly affected. Using the extrinsic fluorophore diphebyl hexatriene (DPH), investigation has been carried out to find changes in membrane fluidity and to elucidate whether alteration of microviscosity of hamycin treated neutrophils has any role in reduced binding of IL-8 to neutrophils and IL-8 induced chemotaxis. Binding of hamycin to the membrane presumably alters microviscosity and fluidity of the membrane which modulate the high affinity receptors resulting in lower binding of IL-8 and reduced migration of neutrophils. The antifungal agents are used therapeutically for the treatment of the patients suffering from fungus infection. Therefore, potential use of the agents as immunomodulator may be considered for preventing the neutrophils from local accumulation in some severe cases (25).

Effect of polyamines :

Putrescine, spermine and spermidine are the naturally occurring polyamines which increase enormously in cancer patient. Putrescine and spermidine at the dose of 0.2 umole and spermine at 0.1 umole could inhibit IL-8 induced migration and reduce IL-8 binding by 60-70%. The total antigenic epitopes as deduced by immunoblot remained almost the same. It indicates that the

downregulation of the receptor was not due to the loss of receptor protein from the cell surface. Scatchard analysis shows that spermine dissociated the single high affinity homogeneous receptor (24,000/cell, Kd 3.4 nM) into small amount of high affinity (4,000/cell Kd 2.6 nM) and large amount of low affinity form (17,000/cell Kd 16 nM). Spermine and spermidine induced released of O_2^- and H_2O_2 from neutrophils. Exposure of O_2^- and H_2O_2 to the intact cells, cell membranes and affinity purified IL-8 receptor caused loss of IL-8 binding by 80% which were fully protected by SOD and catalase. If the two phenomena are correlated, it can be concluded that polymine induced release of toxic oxygen radicals is the possible cause for damaging some of the susceptible amino acids of the IL-8 binding domain which leads to affinity alteration as well as downregulation of IL-8 receptor.

The study indicates that downregulation of IL-8 induced biological responses may significantly impair the neutrophil mediated host immunity where the polyamine level is considerably higher. It further suggests the possibility of the compounds as potential immunomodulators to be used in therapeutic doses for the management of excesslve accumulation of neutrophils in different non-infectious inflammatory diseases (25).

Effect of cytokines :

Since during inflammatory responses a number of cytokines/interleukins are released, local concentration of the cytokines becomes considerably higher. Therefore study of the effect of these inflammtory cytokines on the expression of IL-8 receptor is relevant. Preliminary study indicates that IL-1∝ ,TNF∝ and IL-6 induce IL-8 mediated chemotaxis of neutrophils whereas IL-2 and GMCSF reduces the migration markedly. This increased or decreased migration of neutrophils were regulated by the expression of surface IL-8 receptor. The source of the upregulated receptors and the cause of downregulation of receptors are being examined.

A number of other immunomodulators are being examined to establish their efficacy in reducing IL-8 induced migration and other functions of neutrophils related to the induction of inflammatory responses.

Conclussion :

This study will reveal intricate cellular regulatory machanisms and help to explore signal transduction pathways so far unknown. The receptor for IL-8 has also been identified from other phagocytic cells like monocytes (26) and the regulation of receptor expression of monocytes is also being investigated. It is a matter of great concern that the list of IL-8 related diseases is gradually being increased enormously. The different range of compounds like steroidal and nonsteroidal antiinflammatory agents, cytokines, interleukines etc. are being examined for the regulation of IL-8 receptor expresion as well as IL-8 directed migration of neutrophils. Compounds found effective through thorough investigation *in vitro* will be taken up for *in vivo* study in suitable animal model as potential therapeutic agents predominantly for noninfectious inflammatory diseases. Thus, these information may be helpful in devising rational strategies for ameliorating inflammatory distress of the patients. Neutrophils have both beneficial and detrimental effects in human health. We hope very soon we will be in a position to maximize the beneficial feature of neutrophils while their negative effects by dint of our current knowledge on modulation of the fuctions of neutrophils.

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Fluoride : Its Source, Excusion, Effect and Management

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Abstract

The acute toxicological effects of fluorides are reasonably well understood. Fluorides can cause many damaging effects not only to human beings, but also to animals, aquatic creatures and vegetation. The effects of flourides on human health can appear as death, growth retardation, motting of teeth, kidney injury, thyroid injury, chronic fluorosis and respiratory problems. The effects of flurides on cows, buffaloes, goats, shep, frogs and aquatic creatures are visibly observe mainly in fluoride endemic areas. Vegetation also very sensitive to the air pollutant, hydrogen fluoride. The sources of fluorides may be classified into two broad categories; (1) natural and (2) human made. Natural sources include water, food, soil and mineral, volcanic eruptions etc. Human-made sources cover industries like aluminium smelters, phosphatic fertilizer industries, phosphoric acid industries and fluoride manufacturing industries.

Through the use of fluorides in industial process is indispensable, its toxicological effects on environment calls for adopting proper control technology. Sometimes the control technology becomes self-defeating when it creates undesirable sid effects in meeting objectives. So, the control technology must be considered in terms of both total technological systems (equipment and processes) and ecological consequences such as the problems of treatment and disposal of pollutants.

The paper reviews the source, excursion, effect and management of fluoride pollution in the industial area.

Key-Words : fluoride, environment, scrubbing, poilution, toxic, management.

Introduction

Whatever may be the source of fluoride in the enviroment, natural, or man made, it passes to and from air, water, soil and living organnisms through some definite pathways and ultimately reaches the higher trophic levels through food chains and food webs operating in the natural ecosystems. The excess accumulation of fluorides in vegetation leads to visible leaf injury, damage to fruits, changes in the yield, whereas in animals discolouration, weakening and disintegration of teeth, stiffness of joint have been reported (1).

The Existence of Fluoride

A. NATURAL ENVIRONMENT.

A1. Water : Surface water contains 0.02 ppm to 0.3 ppm of fluoride. Concentration of 0.15 ppm to 0.3 ppm is due to contamination of surface water with agriculture-runoff where phosphatic fertilizer is used. The soruce is here fertilizer which contains upto 2% fluoride.

The highest concentration of fluoride of 25 mg/litre is measured in lakes in Kenya and South Africa (12). However, in ocean water fluoride concentration is around 1.3ppm even upto 2500 meter depth (3).

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The concenntration of fluoride in water mainly depends uopn : (i) geophysical condition of the area.(ii) excursion of subsoil water stream. (iii) accessibility of fluoride into water from industrial sources. (iv) duration of contact of water with fluoride bearing material.

A2. Food : All kinds of food contain trace amount of fluoride.The leafy and watery vegetables and fruits grown in fluoride endemic area, however, contain a large quantity of fluoride to the tune of 300 ppm in dry weight basis, which is directly proportional to the fluoride concentration in environment.

In addition, vegetables grown with application of phosphtic fertilizer give rise to higher fluoride than control areas. Generally, tea conntains high concentration of fluoride due to rich fluoride bearing fertilizers. Fluoride content in different food materials may vary to a wide extent (4).

A3. Soil and Mineral : Minerals are the major source of fluoride. Soil receives fluoride contaminated minerals from the environment. It occurs both in sedimentary and igneous rocks at a concentrationn of 0.06% to 0.09% by weight. The fluoride rich minerals are cryolite (Na_3AlF_6), flurospar (CaF_2) and fluorapatite [$Ca_{10}F_2(PO_4)_6$].

The soil fluoride concentration varies from 0.5 ppm to 8000 ppm depending upon the mineral content.

A4. Volcanoes : Volvanic eruptions studied in Italy, Japan, New Zealand, Mexico indicate that an appreciable amount of gaseous and solid fluoride is discharged into environment.

The products discharged are identified as, (i) Hydrogen fluoride, HF (ii) Ammonium fluroride, NH_4F (iii) Tetra fluoride SiF_4 (iv) Fluoro silicates, Na_2SiF_6, $(NH_4)_2\ SiF_6$. (v) Fluro borates, KBF_4.

B. INDUSTRIAL SOURCE

B1. Phosphatic Fertilizer : For manufacturing superphosphatic fertilizer, ground phosphatic rock is treated with concentrated sulphuric acid. In the process hydrofluoric acid and silicon tetra fluoride are formed. For emission control water spray towers and scrubbers are used which form fluorosilic acid.

$$Ca_{10}F_2\ (PO_4)_6 + 7H_2SO_4 + 3H_2O \longrightarrow 3CaH_4(PO_4)_2.\ H_2O + 7CaSO_4 + 2HF$$
$$SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$$
$$3SiF_4 + 3H_2O \longrightarrow 2H_2SiF_6 + H_2SiO_3$$

Pollution control system in the industries unsually operates at 85% to 95% efficiency. So the rest of the fluoride finds its way into atmosphere.

B2. Phosphoric Acid : Phosphoric acid is manufactured from the same raw material as phosphatic fertilizer with a different kinetics :

$$Ca_{10}F_2\ (PO_4)_6 + 10H_2SO_4 + 20H_2O \longrightarrow 6H_3PO_4 + 10CaSO_4H_2O + 2HF$$

The hydrogen fluoride liberated is again scrubbed at 85% to 95% and the rest gets into environment as pollutant contaminating water, air and soil.

B3. Animal Feed Supplement : In these industries phosphatic rock is processed to remove fluoride content. In this process phosphatic rock is ground, treated with phosphoric acid and heated in a kiln at 1100°C and 1350°C to remove 95% fluoride. The final product is granulated and used as animal feed supplement. The emission, mainly of hydrogen fluoride and carbon

tetra fluoride, is scrubbed. Even then, around 18% to 19% fluoride gets into natural environment contaminating water, air and soil.

B4. Aluminium Smelter : Aluminium technology even today follows Hall-Heroult process. Over the years four types of electrolytic cells are used for aluminium extraction, such as centre-work prebaked, side-work prebaked, vertical-stud Soderburg and horizontal-stud Soderberg. In all the processes electrodes are carbon and electrolyte is cryolite. There is continuous depletion of a Aluminium fluoride in cryolite and carbon in anode. Both the items have to be supplemented constantly.

The reactions are in a smelting process are as follows.

(i) $2Al_2O_3 \longrightarrow 4Al + 3O_2$

(ii) $2C + O_2 \longrightarrow 2\,CO$ ($CO_2 + C \longrightarrow 2\,CO$)

$C + 2F_2 \longrightarrow CF_4$

$CO_2 + CF_4 \longrightarrow 2COF_2$

(iii) $2Na_3\,AlF_6 + H_2O \longrightarrow 6NaF + Al_2\,O_3 + 6HF$

(iv) $Na_3AlF_6 \longrightarrow 3\,Na^{+} + AlF_6^{-3}$

$AlF_6^{-3} \longrightarrow AlF_3 + 3F^{-}$

$12F + 3C \longrightarrow 3CF_4$

(v) $AlF_3 \longrightarrow Al^{+3} + 3F^{---}$

$2Al + 3CO_2 \longrightarrow 2\,CO + Al_2O_3$

$4Al + 3O_2 \longrightarrow 2Al_2O_3$

(vi) $4\,Al + 3C \longrightarrow Al_4C_3$

$4NA_3AlF_6 + 3\,SiO_2 \longrightarrow 2\,Al_2O_3 + 2\,NaF + 3\,SiF_4$

The stack emissionn is controlled by dry and wet scrubbing with an efficiency of 95 - 98 % releasing 1 kg to 3 kg of fluoride per ton of aluminium produced.

There is no effective fugitive control system adopted in the country. So almost the entire fugitive emission is dispersed to natural environment.

The fluoridated cathode carbon is disposed either after recovery of values or as secured land-fill. Even then, the threat of soluble fluoride leaking from the fluoridated cathode carbon still exists. This may contaminate surface water and subsoil water.

B5. Fluoride Manufacturing Process : Hydrogen fluoride is manufactured in commercial scale by heating fluorospar with sulfuric acid at 100°C to 250°C. Hydrogen fluoride is liberated as vapour which is condensed and purified.

$CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2\,HF$

The stray gases such as fluorosilicic acid, carbon dioxide and sulphur dioxide are also liberated as waste gases. This also contaminates the atmosphere after scrubbing.

Aerosol propellant like dichloro-difluoroethylene ($C_2Cl_2F_2$) hexafluoropropylene (C_3F_6) are manufactured from hydrogen fluoride which finally gets into the environment.

Commercial process of manufacturing synthetic cryolite also gives rise to fluoride burden to natural environment. In this process sodium aluminate and sodium hydroxide are treated with hydrogen fluoride to form cryolite;

$NaAlO_2 + 2\ NaOH + 6\ HF \longrightarrow Na_3\ AlF_6 + 4H_2O.$

In petroleum refining hydrogen fluoride, or boron trifluoride, or both are used as alkylation catalyst for producing high octane gasoline. The waste generated from the process liberates fluoride fumes contaminating water and air.

Uranium hexafluoride is manufactured in several stages :

$UO_3 + H_2 \longrightarrow UO_2 + H_2O$

$UO_2 + HF \longrightarrow UF_4 + 2H_2O$

$UF_4 + F_2 \longrightarrow UF_6$

In all the above stages the natural environment is contaminated.

Fluoride compounds are used for firing rockets because of its propellant characteristics. In some cases liquid fluorine, chlorine monofluoride (ClF), chlorine trifluoride (ClF_3), bromine pentafluoride (BrF_5) and oxygen difluoride (OF_2) are used as hyperbolic monitors for solid rocket probellants. If the last firing is for more than 4 seconds, scrubbing of the emission is done. However, by firing at high altitude the atmosphere is contaminated.

Some fluoridated organic compounds are used as pesticides such as, sulfuryl fluride, fluoro-acetamide, fluoro-ethyl acetate. During their manufacture and use as pesticides they contaminate the environment.

The Effect of Fluoride

Gaseous fluoride is ingested into the human system through respiration, whereas particulate fluoride is ingested through respiration, food and drinks. Around 4% of fluoride is retained in the body and the rest is excreted through urine and faeces. All the species develop tolerance to fluoride in fluoride endemic area. The effect on species depends on : (i) the concentration of fluoride to which the receptor is exposed (ii) duration of exposure (iii) severity and duration of the effect (iv) susceptibility and sensitivity of the receptor (v) micro-metereological condition influencing the effect (vi) interaction of two or more pollutants creating synergistic, additive or antagonistic effects.

A. EFFECTS ON HUMAN BEINGS

A1. Beneficial Effects : Fluoride intake at a lower does of 0.7 to 1.0 mg per day for dentine care and 50 to 100 mg per day for skeletal fluorosis are recommended to children. However, the dose response and efficacy are yet to be properly ascertained.

A2. Toxic Effect : Repeated exposure to fluoride is injurious subject to its concentration. The effects with respect to concentration and durationn of exposure on human beings are as follows (5) :

Dose	Time	Amount/Conc.	Effect
Single	2 - 4 hrs	2.5gm to 5 gm	Death
Repeated	10-20 years	20mg to 80 mg	Crippling fluorosis
Repeated	8 years	5 gm to 8 gm	Osteosclerosis

Unlike animals, there is no proven instance of growth retardation retardation in human beings (6). The best study of normal human growth ever made was one which has shown that the children of Newburgh, New York, who drank fluoridated water (1ppm) over a period of 10 years, grew just as well as the children in the nearby control city of Kingston (7). Skeletal fluorosis has been reported mainly from aluminnium production, magnesium foundries, fluorospar processing, and superphosphate manufacture (8). The first stage of osteofluorosis is sometimes asymptomatic and can be visualized radiologically as an increase in the density of various bones, particularly the vertebrae and pelvis. In cryolite workers, such changes were seen after about four years of daily absorption of 20-80 mg of fluoride (9). According to more recent reports, osteosclerotic changes appear at a fluoride content of 5000-6000 mg/kg of dry, fat free bone (10,11,12).

Mottling, disfiguring and discolouring of permanent teeth of children between 8 to 10 years of age are due to ingestion of fluoride through water having 2 to 4 ppm fluoride concentration. The degree of mottling can be severe, moderate, mild or very mild depending upon fluoride concentration in water and duration of exposure. Fluoride is higher in the surface region than in the interior (6).

In dental fluorosis all damages occur before the eruption of the teeth. Brownish back discolouration is due to the deposition of stains from the oral cavity into the spongy surfaceof severely mottled areas. Mechanisms show that the enamel forming cells, the ameloblasts, are affected, the maturationn of the enamel is delayed, and the mineralization process is inhibited through interference with nucleation and crystal growth. Calcium homeostatic mechannisms are affected. Histological changes are found in the enamel and dentin during severe fluorosis (13,14).

Cell-linings are sometimes damaged due to higher exposure to water having 80 to 100 ppm fluoride for a period ranging between 6 months to 1 year. This has been confirmed by epidemiological studies (6, 15).

In cryolite workers, Roholm (10) found only insignificant hamaturia and no albuminuria. A possible relationship between albuminuria and fluoride exposure was suggested by Derry Berry et al. (16). Some other authors show no chronic effect on kidney. No renal disorder has been related to fluoride in areas of endemic fluorosis (17). Other studies show a possible influence of fluoride on people with mainfest kidney diseases. In patients with kidnney failuure, fluoride excretion is decreased, and the ionic plasma fluoride concentration is higher than the normal (18,19,20).

Fluoride is believed to be concentrated at thyroid causing malfunctioning at an exposure to 50 ppm of fluoride in water or food (6). Indepth study, however, shows no relationship between thyroid injury and fluoride intake. Demole (21) suggested that the problem of the toxic effects of fluorine in relation to the thyroid may be regarded as settled; a specific toxicity of fluorine for the thyroid gland does not exist.

Exposure to fluoride concentration of 20 to 80 ppm in water, air or food for a protracted priod of 10 to 20 years is responsible for calcification of ligaments, increased mineralistion of bones and abnormal outgrowth of bones (9).

Fluorosis among people using underground water having 2 to 10 ppm fluoride in some parts of Andhra Pradesh, Rajasthan and Madhya Pradesh is very clearly visible. Fluoride usually

gets accumulated at various points. The quantum of accumulation depends upon intake, age, sex and bone type. Affected bone joints contain 300 to 12000 ppm of fluoride on dry weight basis.

Reactions of gaseous and particulate fluoride occurs in two levels : in conducting air ways and air-exchanging alveolar duct. The magnitude of effect depends on solubility of gaseous fluoride in water medium and size of the particulate fluoride.

Water soluble fluorides like hydrogen fluoride is dissolved with the aquous fraction of tissues of the upper airways and causes inflammatory and corrosive structural changes. The tissues in that zone become partially or fully inactive causing restricted or inconsistent air flow giving rise to respiratory problem.

Particle fluoride of 10 micron size or more are intercepted in the nose. In case these particles find their way in they are easily removed by ciliary action. But the smaller size particles remain suspended, pass through respiratory bronchioles and finally get deposited on alveoli causing respiratory problem.

B. EFFECTS ON LIVESTOCK/ANIMALS

The effects of fluoride on cow, buffaloes, sheep frogs and aquatic animals are visibly observed in fluoride endemic area. The ingestion of elevated level of fluoride has several injurious effects on animals.

Fluoride content in grass and fodder in fluoride endemic area is analysed from 20 to 100 ppm on dry wet basis. The live-stock consuming such amount of fluoride from ration develop the symptoms like Impairment of appetite, low mild yield, dental lesions, severe fluorosis, hoof growth, lameness.

Analyses of milk, urine and faeces of the animal show rise in fluoride level from 2 ppm to 30 ppm. Cowdung analysis reveals still higher fluoride content up to 80 ppm mainly because of indigestion features in it.

The fluoride is concentrated at the tip of the tail bone of livestock.Although there is less consensus regarding tolerable level of fluoride in cattle diet, a total dietary intake of 40 ppm fluoride is often regarded as marginal in causing symptoms. According to Mc Intire et al. (22), tooth markings can occur among cattle receiving 15-20 ppm fluoride in the daily ration.

The urine samples collected from the cows of different age groups from an aluminium industry area (1) showed 11.8 – 36 ppm of fluoride and the concentration had a direct association with the fluoride content in forage and hay. The observations revealed that around 90% of the cattles had mild to severe symptoms of fluorosis in their incisors and the affected teeth were variously stained, chipped and reduced. Occurrence and severity of such conditions depend upon the level of fluoride ingested, duration of ingestion, type of solubility of fluoride ingested, age of animal, level of nutrition and individual metabolic response (23).

The milk yield of fluorotic cows was found to be less than normal cows due to consumption of fluoride contaminated forage (104.92 ± 86.85 and 124.83 ± 105.60 ppm) and their fluoride content increased significantly with a range of 0.381 to 0.770 ppm as compared to 0.78 ppm of fluoride in normal cows (24).

C. EFFECTS OF FLUORIDE ON VEGETATION

Fluoride is taken in by plants from the soil and ground water by passive diffusion, which is then carried to the shoot by transpiration. Gaseous and particulate fluorides in the air are deposited

on the plant surface. Gaseous fluoride enters into leaves throughh stomatal pores. Fluoride that penetrates the internal tissues of the leaves affects a variety of metabolic processes interfering with appearance, growht and reproduction.

Fluoride accumulation at the top and margin of the leaves gives rise to necrosis and chlorosis. Necrosis reduces and deforms the leave, whereas chlorosis reduces chlorophyll content and photosynthetic activity. Narrow and pointed leaves are more susceptible to fluoride affect. Fluoride content in gass and paddy leves gives rise to fodder fluoride which mainly affects livestock through food chain.

Natural vegetation has been used as bioindicator of spatial fluoride distribution by Carlson (25), Israel (26) and Kay (27). Some areas of the United States with levels upto 36 ppm have been reported in alfalfa plant (28) and Rao and Pal (1) found a range of 25-195 ppm in forage, 18.5–46 ppm in hay collected within a radius of 0.5 to 1 km of an Aluminium factory with an average of 5.2 ppm in control site.

D. EFFECTS OF FLUORIDE ON AQUATIC ANIMALS

Effects of fluoride have been experimented on several aquatic animals, chiefly on fish. Fishes exposed to poisonous amount of sodium fluoride become apathetic, lose weight, have periods of violent movement, and wander aimlessly. Finally, a loss of equilibrium is seen accompanied by tetany and death. Mucous secretion increases, accompanied by proliferation of mucous producing cells in the respiratory and integumentary epithelium (29). Loss of length and weight of fishes could be seen in fresh water fishes kept in captive pond of an aluminnium factory at Hirakud (30). Other data show loss of weight in amphibians (Bufo melanostictus) accompanied by decrease in haemoglobin, hematocrit, red blood cells. There is high accumulation of bone fluoride content in amphibians like *Rana cyanophlyctis* (1100 µg/g to 3200 µg/g). Studies on other aquatic animals show that Crustaceans may be more tolerant to fluorides than fish (31). Gikunju (32) Shows higher values of fluoride in case of fish (210.6 µg/g). In arctc Char bone fluoride content exceeds 1,150 mg/kg (33). Studies on the effect of fluoride on aquatic animals show that sensitivity and lethal doses are inlfuenced by many factors, e.g. size of the organisms, density of the organism per cubic meter of aquarium, water temperature etc. (34).

Control of Fluoride Pollution

A. GASEOUS FLUORIDE

Industrial emission having higher percentage and fluoride gases of fumes is cleaned through wet scrubber or dry scrubber before releasing to the atmosphere.

A1. *Wet Scrubbing* : Wet scrubbbing generally consists of two phases. In the first phase, the particulate fluoride is removed from the emission by E S P or multiventuri depending on the ratio of particulate and gaseous fluoride. However , ESP is found to be less efficient and more expensive. So this technology is almost superseded by multiventuri where the same scrubbing is used for particulate separation.

In the second phase, the gas is passed through scrubbing medium in counter current direction to the scrubbbing liquid. The scrubbing liquid is selected depending on the solubility of the gas and spraying system adopted.

A2. Dry Scrubbing : In dry scrubbing system, industrial emission having higher percentage of gaseous fluoride is passed through fine particles of alumina. Fluuoride gases and fumes are absorbed in the surface of almumina particles, which could be easily removed to release cleaned gases into atmosphere. Fluoride absorbed alumina is used as a raw material in smelter and as mineraliser in cement industry.

B WATER BORNE FLUORIDE

As discussed earlier, underground water contains fluoride upto 27 ppm. Ground and surface water is also contaminated with fluoride from industrial solid waste upto 10,000 ppm or more depending upon the nature of solid waste. NEERI developed a technique called "Nalgonda Technique" using flocculation, sedimentation and filtration concepts, which was found to be cost effective. This technology has been modified over a period of time and used for defluoridation of ground water in Tamilnadu, Andhra Pradesh and Rajasthan. In the above process, lime is added to ground water to convert soluble fluoride to insoluble calcium fluoride. This process reduces fluoride slightly below 7 ppm. But again when alum is added the calcium fluoride is flocculated and settles down. Also, fluoride ions are adsorbed on alum and settle down alongwith calcium fluoride to reduce fluoride concentration below 2 ppm. Water is to be filtered and used. In case of industral effluent containing 100 ppm and more, the same principle is adopted with modifications.

Management of Fluoride and Fluoride Pollution :

In industry fluoride bearing materials are used both in a solid as well as a liquid state. First of all, the user should obtain Material Safety Data Sheet (MSDS) from the supplier, display it in an appropriate location and educate the operator on handling, storage, use and disposal of the material. The medical personnel should be trained and equipped to attend any emergency.

The use of fluoride in industrial process can not altogether be ruled out. The toxic effect of the material is well known. The material is also very costly. Defluoriation of effluent and de-toxication of fluoride bearing solid waste are equally costly. So the extent of economic involvement plays a vital role in fluoride pollutionn management. But considering the damage to the environment a mere burden on production cost should not be the only consideration. To control the fluoride pollution adequate control measures are to be taken in the following stages of excursion of fluoride in industry :

(i) *Isolation* : All fluoride bearing materials, either in solid or liquid form are to be stored under a shed over a polythene lined concrete floor. The material is first sealed in air and water tight polythen bags, followed by an external cover of gunny bags.

The liquid containers should be properly designed for mechanical stress and strain and properly sealed. The safety instructions to be followed during transit should be printed on the container.

The above procedural measures must be taken to eliminate spillage, contamination and leaking.

(ii) *Process optimisation* : Operating stages are to be optimised not onnly for financial consideration but also for minimising pollution.

(iii) *Emission monitoring and control* : The gaseous fluoride emission should be monitored perferably with a continuous monitor and printing device. The concept of dilution and

dispersion of fluoride is suicidal. Always the emission is to be controlled below international bench-mark by adopting the state of art technology. The operators in the shop floor must be given double catridge respirators with fluoride filters. The employee's urine should be analysed for fluoride and if the post shift concentraction shows 5 ppm or above, he should be isolated from the process.

(iv) *Solid waste management :* Though gaseous fluoride only contaminates air, the solid waste bearing fluoride contaminats air, water and soil. So this solid waste should not be treated only as a waste but as a by-product.

No viable technology is available in the counrty for detoxication or to convert the fluoride bearing waste as an environment friendly product.

EPA approved/secured land-fill design is available but this is not a long term solution. This is a technology which will create hazards to our future generation.

(v) *Defluoridation of effluent :* The technology for defluoridation of water is available in the counrty. However, this process can reduce the concentration to 5 to 7 ppm level. Beyond this level dilution is the only solution. The effluent quality standard for fluoride is 10 ppm as stipulated by the Central Pollution Board. This should be minimised in the interest of environment. Studies indicate that an area having windy climate and normal green coverage can take a miximum load of 700 MT of fluoride per year. So the management of fluoride in our industry should be environment friendly.

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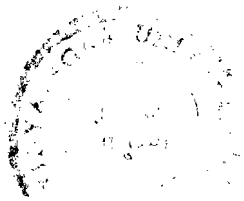

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A Study of Certain Crop and Non-Crop Plants in Relation to Salinity : Tolerance to Salinity and Recovery from Toxicity

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Abstract

The effect of different salts was studied on the seed germination of seven rice (Oryza sativa) cultivars. While all were found to have decrease in germination percentages with increasing salinity, seeds always responded to 0.1M of all salts. At a concentration of 0.3M, germination ensued in the presence of two chlorides (NaCl & KCl) and one sulphate ($MgSO_4$) only. Above this level, i.e. 0.5 & 0.7M, seeds did not germinate at all. Among the cultivars, Latisail seemed to produce maximum germination and this was followed by Satika. At 0.1M, Latisail and Satika produced seed germination inn the following order : $NaHCO_3$ > Na_2CO_3 > K_2CO_3 & Ca $(NO_3)_2$ > KNO_3 or $NaNO_3$. Germination maxima for Jhingasail was obtained with two salts, e.g. 0.1M NaCl & 0.1M $MgSO_4$. The same for Ratna and Dharial was available at 0.1M KCl & 0.1M NaCl respectively. Dular could germinate poorly in seven different salts, all at 0.1M.SR-26B did so in four different salts — NaCl, Na_2CO_3, K_2CO_3, Na_2SO_4. No delay in germination was evident in all chlorides. For all sulphates and nitrates, there was only one-day delay. In case of carbonates, both SR-26B & Dharial germinated on the fifth day. Seeds of Acanthus ilicifolius failed to germinate in Na_2CO_3, $NaHCO_3$ & K_2CO_3. Germination took place in $CaCl_2$, $MgCl_2$, Na_2SO_4, KNO_3 & $Ca(NO_3)_2$ — all at a concentration of 0.1M.

When Hygrophila salicifolia seeds were soaked in solutions of KCl, $NaHCO_3$, $MgSo_4$, $NaNO_3$ & KNO_3, large seeds germinated better than small seeds and there was no delay for both seed forms. While small seeds did not germinate in $CaCl_2$, $MgCl_2$ & KCl, germination was delayed for large seeds in these salts.

In Suaeda maritima, seed germination is concentration dependent. Black seeds germinated better than red seeds in 0.3M $MgCl_2$, 0.3M K_2SO_4, 0.1M $MgSO_4$, 0.3 & 0.5M KNO_3 and 0.1M $Ca(NO_3)_2$. Moreover, red seeds performed better than black seeds with the use of 0.3M $NaCl_2$, 0.1M $MgCl_2$, 0.5 & 0.7M Na_2CO_3, 0.3 & 0.7M $NaHCO_3$, 0.5 & 0.7M K_2CO_3, 0.5 & 0.7M K_2SO_4 & 0.1M KNO_3. There was a delay for black seeds at 0.5–0.7M $NaNO_3$ as well as KNO_3 and for red seed at 0.1M KCL. Seed germination of the two seed forms stood in the following order —NaCl > $NaHCO_3$ > Na_2SO_4 > Na_2CO_3> $NaNO_3$ — for sodium salts at 0.3M. The order was K_2SO_4 > KCl >K_2CO_3 > KNO_3 for potassium salts and $CaCl_2$ $CaN(O_3)_2$ for calcium salts. Using the same level, germination was poorest in $MgCl_2$ among the chlorides; K_2CO_3 among carbonates, $MgSO_4$ among the sulphates and $Ca(NO_3)_2$ among the nitrates.

Introduction

Salinity is one of important factors affecting crop production and most crops respond to salts halophytes. One of the important attributes of halophyte seeds and possibly the chief feature distinguishing them from glycophytes could be the seeds' capacity to remain dormant for long periods under extremely high salinities and then sprout at a later time when soil-water potentials are raised (7). This is of survival value and represents an evolutionary adaptation essential for annual species inhabiting salt-marsh environment characterised by sharp fluctuations in soil-salinity conditions. Germination recovery, after soaking seeds in salt solutions which are inhibitory, points out that no ion-toxicity is generated and the primary effect of excess salts may be osmotic.

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Though investigations of specific-ion influences on the germination of halophyte seeds have been somewhat inconclusive, findings emerged from several glycophytes are indicative of specific-ion inhibition. These would become appropriate under field conditions if all combinations of ions were uniformly abundant in nature. In general, sodium chloride has been known to be least toxic in tests with isotonic solutions and is one of the more significant salts regulating the distribution of halophytes.

Some of the basic questions still asked by researchers include one concering why some seeds are more salt-tolerant than others. We also seek to ascertain whether the principal effect of salinity is osmotic inhibition or ionic inhibition or a combination of both. Research related to these problems were carried out by utilizing Suaeda maritima, a typical halophyte, and comparing its response to crop (Oryza sativa) and non-crop species (Acanthus ilicifolius & Hygrophila salicifolia). This was performed by soaking seeds in various concentrations of soluble salts and then transfering the unresponded seeds to water. The action of the different saline solutions on seed germination as well as root and hypocotyl growth of seedlings was examined.

Materimal and Methods

In the present study, seed material of the following species were collected from different areas of West Bengal :

(i) Rice (*Oryza sativa* Linn.) —Poaceae— cultivars – Dular, Ratna, Latisail, SR-26B, Dharial, Jhingasail and Satika–from Chinsurah Rice Research Station, Hooghly.

(ii) *Acanthus ilicifolius* Linn. — Acanthaceae — from Taldi, 24-Parganas (South).

(iii) *Hygrophila salicifolia* Nees — Acanthaceae — two seed forms (larger, 11.6 mg & smaller, 6.5 mg — from Taldi, 24-Parganas (South).

(iv) *Suaeda maritima* Dumort — Chenopodiaceae — two seed forms (black & red) — from Canning, 24-Parganas (South).

Tolerance of seeds to salinity was determined by subjecting four 25-seed (10-seed in A. ilicifolius) replicates to four salinity regimes : 0, 0.1, 0.3, 0.5 & 0.7M. Seeds were scattered in 5-cm Petridish (in case of H. Salicifolia & S. maritima) and 11-cm Petridish (in O. sativa & A. ilicifolius) containing one disc of Whatman paper no. 1 moistened with 2.5 and 10 ml respectively of water or test solution. The salts employed were four chlorides (NaCl, Kcl, $CaCl_2$ & $MgCl_2$); three carbonates (Na_2CO_3, $NaHCO_3$ & K_2CO_3); three sulphates (Na_2SO_4, K_2SO_4 & $MgSO_4$) and two nitrates [NaNO3 and $Ca(NO_3)_2$].

Germination was scored daily for 1 wk. After this initial period, ungerminated seeds from salt treatments were put in Petridishes containing 2.5 or 10 ml of distilled water for additional 1 wk.

The emergence of radicle was selected as a criterion for germination. Total germination percentage and the time taken to commence germination as well as maximum germination were recorded. The length of root hypocotyl was measured to the nearest cm both before and after transfer to water from various salinities. This was followed for all test species except A.ilicifolius (where hypocotyl did not emerge during the experimental period of 14 days).

Results and Discussion

Both crop and non-crop species were found to have a decrease in germinationn percentage with increasing salinity. Moreover, all cultivars of rice (Oryza sativa) as well as black and red seed forms

of Suaeda maritima responded to all the 13 salts tried. While Oryza always germinated in 0.1M concentration of three salts, the upper limits of salt stress at which *Suaeda* would germinate were 0.5-0.7M K_2CO_3 & K_2SO_4. Neither *Acanthus ilicifolius* nor *Hygrophila salicifolia* could germinate in solutions of all salts. As a matter of fact, Acanthus seeds failed in all carbonates and *Hygrophila* only in the presence of Na_2CO_3 in the germinating media.

Among cultivars of *O. sativa*, Latisail seemed to be most salt-resistant and Dular most salt-sensitive. At 0.1M, this crop alongside three non-crops, showed a trend in inhibition which depended on the specific action of certain salts. Both Latisail and Satika produced seed germination in the following order : $NaHCO_3$ > Na_2CO_3 > K_2CO_3 & $Ca(NO_3)_2$ > KNO_3 or $NaNo_3$. For A. ilicifolius, at the same concentration, germination values stood in the fashion of KCL or NaCl > $MgCl_2$ > $CaCl_2$ for the chloride series ; K_2SO_4 or $MgSO_4$ > Na_2SO_4 for the sulphate series and KNO_3 & $NaNO_3$ > $Ca(NO_3)_2$ for the nitrate series. As to H. salicifolia, comparative figures for germination followed the pattern of KCL > NaCl > $MgCl_2$ > $CaCl_2$ for large seeds and KCl > NaCl for small seeds. Though no such trend at the same concentration was available for the two seed forms of S. maritima, germination ran according to schedule of NaCl > $NaHCO_3$ > Na_2SO_4 > Na_2CO_3 > $NaNO_3$ for the sodium series; K_2SO_4 > KCl > K_2CO_3 > KNO_3 for the potassium series and $CaCl_2$ Ca $(NO_3)_2$ for the calcium series, all at the same level of salinity (0.3M) in this species. A perusal of these results indicated that *O. sativa* germinated better in the presence of $NaNO_3$ than $Ca(NO_3)_2$ and A.ilicifolius duplicated the same. Both *A. ilicifolius* and *H. salicifolia* followed suit as far as the action of $MgCl_2$ and $CaCl_2$ was concerned, but H. saliffifolia fared better in KCl than in NaCl and both salts were equally effective in a. ilicifolius. Thus, *O. sativa, A. ilicifolius* and *H. salicifolia* were characterised by their resistance to certain anions — chloride/carbonate/sulphate/nitrate. On the other hand, *S. maritima* seemed to resist the action of cations such as sodium, potassium and calcium.

A delay in response was noted in seeds of both crop and non-crop species. In caltivars of *O. sativa*, seeds germinated on the fifth day in the presence of carbonate and third day in the presence of both nitrate and sulphate in contrast to the second day for untreated control. The delaying effect of certain anion (carbonate) was evident in Dhariwal and SR-26B, while the specific action of sulphate was consipicuous in A. ilicifolius where the seed size was not a factor to reckon within the salinity problem. In both *O. sativa* and *A. ilicifolius*, germination delays were exemplified by 0.3M levels of salinity. Such delays were more intense with larger seeds of *A. ilififolius* than with smaller seeds which did not respond at all in the presence of three chlorides — $CaCl_2$, $MgCl_2$ and KCl. In S. maritima, germination delay was manifested in black seeds at 0.5-0.7M $NaNO_3$ & KNO_3 and in red seeds at 0.1M KCl. The delay was prominent in the presence of 0.3M $MgCl_2$ & $Ca(NO_3)_2$ as well as 0.7M Na_2CO_3, $NaHCO_3$ & Na_2SO_4. Thus, germination delays could be attributed to any specific chain of anions for the first three species and cations (potassium & sodium) could be largely held responsible for the response of *S. maritima* seeds. Finally, the delaying process might be caused by the deployment of a concentration greater than 0.1M — a level which might be hailed as inhibitory as far as initial germination counts were concerned.

Studies with behaviour of crop and non-crop seeds indicated that there was no germination-inhibition up to 0.1M, but treatments ranging from 0.3 to 0.7M caused a decline in the percentage of seeds germinated which was directly related to augmented salinity. Ungerminated seeds from 0.3 to 0.7M were not permanently damaging for various rice cultivars as well as black and red-seed forms of *S. maritima*. When such seeds were sown in petri-dishes saturated with distilled water, the total number of seeds germinating was always higher prior to water transfer and regardless of the original salinity treatment.

The root growth of Ratna cultivar of rice seemed to be uniformly increased after subjecting their seeds to pre-treatments with 0.3-0.7M concentration of all the thirteen salts. The Satika variety, whose germination was initially augmented in the presence of 0.1M Na_2CO_3, $NaHCO_3$ & K_2CO_3 as well as 0.3M KCl & $MgSO_4$, responded to a greater root growth after their seeds were soaked in 0.3M concentration of KCl and $MgSO_4$ as well as Na_2SO_4, K_2SO_4 and $Ca(NO_3)_2$. Even SR-26B, which registered poor germination under lower salinities, improved root growth considerably after their seeds were pretreated with 0.7M Na_2SO_4 & K_2SO_4. As regards the hypocotyl growth of Ratna and Satika cultivars 0.3M Ca $(NO_3)_2$ was equally tolerated by them. But Ratna responded better to Na_2SO_4 & K_2SO_4 and Satika to KCl, Na_2SO_4, K_2SO_4 & $MgSO_4$ — all at the same level of salinity (0.3M). Interestingly, neither NaCl nor KCl had any promotive impact on the seedling growth of various cultivars of rice. The maximum tolerance of salinity differed, with a continuum of change from the most (Latisail & Satika) to the least salt-tolerant (SR-26B & Dular). It appeared to be advantageous for rice seeds to sprout during the season of high precipitation and relatively low evaporation when salt stress was not supreme. Data on the seed germination of rice, a glycophyte, thus indicated that the above salts acted osmotically rather than through a specific-ion toxicity.

Recovery experiments on the halophyte *S. maritima* demonstrated that the major effect of high salinity could be osmotic. While black and red seed forms responded uniformly after transfer to water from various salinities, root growth was better in seedlings arising from red seeds than from black seed when seeds were pretreated with K_2SO_4 & $MgSO_4$. However, pretreatment of S. maritima seeds with KCl & $MgCl_2$ produced root growth and hypocotyl growth being above and below the corresponding controls at and 0.3-0.5 concentrations respectively. Pretreatment with nitrates, chlorides, sulphates and carbonates strongly influenced final germination results of this species. However, there was no consistency in response of these ions while all carbonates were effective in promoting germination of the two seed forms at the highest concentration (0.7M), 0.5M level of chlorides as well as sulphates stimulated germination of both forms. Hence, relative toxicities of these salts in descending order were 0.7M carbonates > 0.5M chlorides/sulphates> 0.3M nitrates for the seed germination of *S. maritima*. Though the status of two chlorides (KCl & $MgCl_2$) was the same as two sulphates (K_2SO_4 & $MgSO_4$) when germination counts were taken into account, these chlorides yielded higher root growth when the salinity level was 0.3-0.7M and higher hypocotyl growth when the effective strength was 0.3-0.5M. A minimum concentration (0.3M) of these salts was necessary to augment seedling growth of *S. maritima* and that only, with salts of potassium and magnesium.

Saline treatments at lower water potentials had mainly an osmotic effect of the seeds of S. maritima, possibly either by preventing seeds from imbibing water or inhibiting enzymatic or hormonal activity. This adaptation, which permitted seeds to withstand exceedingly low water potentials (0.5-0.7M) was of survival value for those plants because drought in the spring or summer would raise salt-stress beyond the limits of seed germination and seeding establishment. Large number of these seeds could be killed because of increasing salinity when the surface water evaporated. Remaining dormant at this period of stress would ensure a part of the population would then survive to germinate and complete their life-cycle later when soilwater potentials were less unfavourable. Soil salinities could, therefore, certainly be considered an important limiting factor in determining when the seed germination of *S. maritima* would occur.

Compared to *S. maritima*, soaking seeds of *A. ilicifolius* in highly saline solutions was inhibitory. In fact, germination response to three salts — Na_2CO_3, $NaHCO_3$, & K_2CO_3 — was toxic, recovery treatments in water produced no germination at all even at the minimum concentration (0.1M).

Other salts promoted seed germination in this species, with the effect being concentration-dependent. While the effective strength was 0.1M for K_2SO_4 & Ca $(NO_3)_2$, it was 0.3M for $CaCl_2$ & Na_2SO_4 as well as 0.5M for $MgCl_2$, $NaNO_3$ & KNO_3. Even root growth improved considerably after transfer to water from various salinities (except carbonates) ; here osmotic inhibition or matric stress was more significant than ionic toxicity or stress. Since seeds of A. ilicifolius remained soaked in carbonate solutions for 7 days, the suppressive action of salinity (at both higher and lower concentration) was irreversible. A case of specificion toxicity can be cited for a species which may regarded both as a glycophyte and a halophyte. Specific-ion toxicities were noted by Chaudhuri (2) in a study of steppe plants in Washington where Na_2CO_3 salinity was more toxic than NaCl or Na_2SO_4. Here sodium chloride usually was least harmful — a finding which also emerged from the present work.

In comparison with the seed germination of *A. ilicifolius*, *H. salicifolia* seeds germinated in the presence of $NaHCO_3$ & K_2CO_3 solutions and failed to do so in Na_2CO_3. Alongside Na_2HCO_3 & K_2CO_3 *H. salicifolia* could cope with a salinity greater than 0.1M in the rest of 10 salts. Under the regime of chlorides, the two seed forms of *H. salicifolia* exhibited a trend for larger seeds (KCl > NaCl > $MgCl_2$ > $CaCl_2$) and smaller seeds (KCl > NaCl). This is indicative of the fact that larger seeds could sustain the action of chloride better than smaller seeds. Larger seeds also responded better than smaller seeds in solutions of KCl, $NaHCO_3$, $MgSO_4$, $NaNO_3$ & KNO_3. But no germination delays took place with the use of three chlorides (except NaCl) and the delays were more with larger seeds than smaller seeds. Whereas larger seeds meant larger sedlings and smaller seeds smaller seedlings, both root and hypocotyl growth decreased below the corresponding controls when seeds were pretreated with 0.1M $CaCl_2$ & $MgCl_2$. Following the pretreatment of H. salicifolia seeds with two chlorides (NaCl & KCl) ; three carbonates (Na_2CO_3, $NaHCO_3$ & K_2CO_3); two nitrates ($NaNO_3$ & KNO_3) and on sulphate (K_2SO_4), increased root and hypocotyl growth above the corresponding controls. Although hypocotyl growth generally seemed to be higher than the corresponding root growth, 0.1M $Ca(N)_3)_2$ solution could be picked up as an exception inducing root growth better than hypocotyl growth at the same concentration. With the remaining 12 salts, only 0.3M $CaCl_2$ produced fresh growth after transfer to water and none of the 11 other salts could come up to this level. As seedlings of S. maritima could survive maximum salt stress (0.7M) and seedlings of H. salicifolia failed to do so, the latter could be termed a glycophyte and not a halophyte. Montfort and Brandrup (6) as well as Montfort (5) opined that halophytes were more salt-tolerant than glycophytes at the germination stage, but that germination was both reduced and delayed at saline solutions.

In view of the fact that water imbibition is retarded by low-water potential. Magistad (4) stated that germination at low-osmotic potentials probably created a weakened radical and plumule. Apparently, the germination phase is exposed to higher surface-soil salinites than are later development periods. For this reason, in certain instances, the seed-germinatin phase is less tolerant of high salinities than the mature phases of development.

Uphoff (8) claimed that there was little difference in the response of halophytes and glycophytes to low-water potentials and differences were recorded only in the limits of salt tolerance. A major difference, however, may by the capacity of halophyte to survive soaking at low-water potential and respond subsequently when salt stress decreased while glycophytes may be less sensitive to these conditions. Binet (1) reviewed the gamut of literature on germination and emphasised that most halophyte species had optimum germination in distilled water. In some species, high salinity might be essential for germination or for eliminating dormancy and promoting the velocity of germination. Henckel (3) asserted that the mechanism by which species adapted to high-salt concentration was

binding the ions to cytoplasmic protein. This would perhaps require more protein than the species could manufacture for this purpose. It may be concluded that this response of halophytes to salinity at the germination stage is similar to glycophytes slowing the germination speed and reducing the final germination percentages.

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A Census of the Geraniaceas Juss. in West Bengal

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Abstract

The present census records *Geranium* as the sole representative of the Geraniaceae in West Bengal having five species dispersed in the subtropical and temperate regions of Darjeeling Himalaya, viz. *Geranium donianum*, *G. Lamberti*, *G. nepalense*, *G. polyanthes* and *G. refractum*. The lastly named species i.e. *G. refractum* appears to be a new record for the state.

Key Word : Geranium, Darjeeling Himalaya, West Bengal with G. refractum as a new record

Introduction

The Geraniaceae, a herbaceous family of Rosidae under Magnoliopsida (1,2) is represented in the world by five genera and about 750 species (3). However, according to Chant (4) the number of genera is 11. The Geraniaceae has evoked considerable interest to resolve its attributes pertaining to taxonomy (5-8), anatomy (9), palynology (10), cytology (11-13) and chemotaxonomy (14-15). According to Dahlgren (16), Zygophyllaceae, Erythroxylaceae, Humiriaceae, Linaceae, Oxalidaceae and Geraniaceae, the main families of the order Geraniales, seem to form a fairly homogeneous group. The Geraniaceae appears to be closest to Oxalidaceae.

The family is cosmopolitan being mainly distributed in the subtropical and temperate regions of both the hemispheres. Some species of Geranium occur in the arctic as well as antarctic regions. It prevails in India in the form of three genera viz. *Erodium, Geranium* and *Monsonia* (17). *Palargonium capitatum, P.cucullatum* and *P. graveolens* are grown in Shevaroy Hills in Tamil Nadu for Geranium oil.(18). Species of *Biebersteinia* have been discovered from the alpine regions of West Himalaya (19). In view of the absence of a collective up-to-date information about the Geraniaceae in West Bengal the present investigation was undertaken.

Methods

This work is based on careful study and scrutiny of partinent literature, specimens preserved in the Central National Herbarium (CAL), Lloyd Botanic Garden (LBG) and those collected from field trips in conformity with the earlier work (20). Comprehensive key to the identification and diagnostic features of the species are provided to facilitate their identification. The taxa are arranged alphabetically with correct nomenclature, citation and information regarding flowering and fruiting periods, distribution, specimens examined etc.

Results

The Geraniaceae is represented in West Bengal by five species of *Geranium* and comprehensive key to the identification of the taxa is presented under the cover of the following taxonomic discourse.

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GERANIUM Linn.

Herbs or undershrubs; leaves orbicular- 5-gonal. lobed; peduncles 1-2 flowered, axillry, umbelled; flowers actinomorphic, pentamerous, hypogynous, bracteate; sepals 5, imbricate; petals 5, imbricate, alternating with 5 glands; stamens 10, 5 may be without anthers, free or somewhat monadelphous; carpels 5, ovary superior, 5-celled, beaked; style 5 with longitudinal stigma; ovules superposed; fruit a 5-lobed and 5-celled dehiscent capsule separating septifragally with the beaks elastically coiling from base to apex of the axis; seeds exalbuminous or with scanty endosperm.

KEY TO THE SPECIES

1. Leaves orbiculo-reniform, deeply 5-9 lobed; peduncles clustered amongst the uppermost leaves, carpels coarsely reticulate ... 4. *G. polyanthes*

1. Leaves orbicuar or 5-gonal, 5-7 lobed; peduncles axillary and terminal, solitary; carpel smooth:

    2. Flowers large, exceeding 2 cm in diameter :

        3. Petals refluxed ... 5. *G. refractum*

        3. Petals spreading :

            4. Leaves orbucular; stipules free, lanceolate ... 1. *G. donianum*

            4. Leaves 5-gonal; stipules 2-fid or in pairs, ovate ... 2. *G. lamberti*

    2. Flowers Small, less than 2 cm in diameter ... 3. *G. nepalense*

1. *Geranium doniaum* Sweet, Geran. 4, Subt. 338. 1827; Wall. Cat. No. 8565. 1847-48; Hara in Kihara, F. & Fl. Nep. Him. 1 : 168. 1955, 3: 72. 1975 and in Enum. Fl. Pl. Nep. 2: 67. 1979; Bennet, Name changes Fl. Pl. India 255. 1987.

    G. multifidum D. Don, prodr. fl. Nep. 207 (Feb. 1, 1825); non Sweet, Geran. 3: t. 245 (Feb. 1, 1825).

    G. collinum auct. non Bieb : Edgew. and Hook. f. in Hook. f., FBI 1 : 429. 1874. p.p.

A perennial herb; stem short, hoary or glandular pubescent; leaves petiolate, covered with long hairs on nerves beneath, orbicular, 5-7 lobed, each lobe incised into 3-5 segments; peduncle slender, pebescent or glandular hairy, often purple tinged, 2 flowered; flowers purplish pink; sepals shortly awned; anthers pale yellow or pale purplish, filaments long ciliated. Flowering and fruiting : June– September.

Flrs & Frts	:	June to September.
Distrib.	:	Eastern Himalaya : Nepal to Bhuten; South Tibet; between 3200-4800m.
Speciment examined	:	Tonglu, 4110 m, F.E. Young; B.K. Bhanjan, 4000m, YHB 606; Gairibas, 4334m, Ribu and Rhomoo 7518 (LBG).

2. *Geranium lamberti* Sweet, Hort. Brit. 492. 1827; Hara in Fl. E. Himal. 2 : 68. 1971, 3 : 72 t. 4C. 1975 and in Enum. Fl. Pl. Nep. 2 : 76, 1979; Bennet, Name changes Fl. Pl. India 255. 1987.

G. grevelleanum Wall., Pl. As. Rar. 3 : 4, t. 209.1831; Edgew. et Hook. f. in Hook f., FBI 1: 430. 1874. p.p.

G. eriostemon auct. non Fisch : G. Don, Prodr. Fl. Nep. 208. 1825.

A tall, branched, hairy and glandular herb; leaves 5-gonal, 5-lobed, lobes rhomboid, ultimate lobules ovate; stipules free, lanceolate or broadly lanceolate; peduncle solitary, axillary, elongate, 2-1 flowered; pedicels eglandular, pubescent; flower pink, rarely white with purple veins. 4-6 cm in diameter; petals spreading ovary white-hirsute.

Flrs & Frts : June to September.

Distrib. : Himalaya : Kashmir, Kumaon to Bhutan; South Tibet; between 3200–4200m.

Specimens examined : LB Garden, 2000m, J.K. Maheswari 4966 (CAL); between Tonglu and Lachen, Smith & Cave 2532 (CAL), Achung, Smith & Cave 2618 (CAL).

3. *Geranium nepalense* Sweet, Geran. 1 : t. 12. 1820; Edgew. et Hook. f. in Hook. f., FBI 1 : 430. 1874; Banerji in J. Bombay Nat. Hist. Soc. 53: 154. 1955, 55: 252. 1958, in Rec. Bot. Surv. India 19(2): 29. 1966; Hara in FL. E. Himal. 1: 167. 1966, 3: 74. 1975 and Enum. Fl. Pl. Nepal 2: 76. 1979; Mukherjee, Fl. Pl. Darj. 54. 1988.

G. affine Wight et Arn. Prodr. 133. 1834, non Ledeb. 1831; Wight, Ic. t. 59. 1838.

A diffuse, eglandular herb; leaves 5-gonal, deeply 3-5 lobed, lobes rhombic with ovate obtuse or acute teeth; stipules free, linear-lanceolate; peduncle slender, 1-2 flowered, axilllary; flowers small, pale pink to rose-purple, 8-17 mm in diameter; sepals shortly awned, equalling petals; ovary with minute hairs.

Flrs & Frts : January to September.

Distrib. : Afghanistan, Himalaya , N. Assam, Tibet, N. Burma, N. Indo-China, W. China; Nilgiri; between 1400-2500m.

Specimens examined : Pankhabari, 1400m, YHB (LBG); Darjeeling, 2000 m, G. Wall. 7017 (CAL); Senchal Lake, 2400 m, J.K. Maheswari 4024 (CAL); Victoria Fall, S.K. Majumdar 5719 (CAL); Darjeeling, 2000m, A. Mukherjee 142.

4. *Geranium polyanthes* Edgew. et Hook f. in Hook. f. FBI 1: 431. 1874; Banerji in Rec. Bot. Surv. Ind. 19(2): 29. 1966; Hara in Fl. E. Himal. 1: 167. 1966, 3: 73. 1975 and in Enum. Fl. Pl. Nep. 2: 79. 1979.

A slender, sparingly hairy herb, leaves orbiculo-reniform, deeply 5-9 lobed lobes obovate, incised into obtuse lobules; stipules connate; peduncles gathered at the top of erect stems, subumbellate, 1-flowered, often short; flowers red purple, 15-30mm. in diameter, sepals with long, spreading soft, glandur hairs; ovary coarsely reticulate.

Flrs & Frts : July to September.

Distrib. : Tonglu - Sandakphu in Darjeeling and other parts of the Himalaya (Kumaon to Bhutan), N. Assam; between 2400-4500m.

Specimens examined : Kalimpong, 1800 m, YHB 96 (LBG), Tonglu-Sandakphu, YHB 2016 (LBG).

5. *Geranium refractum* Edgew. et. Hook. f., FBI 1: 428. 1974; Hara in Fl. E. Himal. 3: 73. 1975, in Fl. Pl. Pl. Nep. 2: 76. 1976.

A tall, robust, branched herb with glandular hair; leaves deeply 5-7 lobed, lobes broad, rhomboid, deeply incised; stipules large, connate, oblong ovate; peduncle solitary, 2-flowered, pedicels densely clothed with spreading hair; flowers nodding, 25-40 mm in diameter; sepals shortly awned; petals reflexed, white with purple veins; ovary tomentose.

Flrs & Frts : June to September.

Distrib. : From Nepal to Bhutan in the Himalaya; between 3500-4800m.

Specimens examined : Chuntung, YHB (LBG); Phalut, 3800 m, W.W. Smith 4293 (LBG).

Discussion

Geranium is the only genus representing the family Geraniaceae in West Bengal their habitat being located in the Darjeeling Himalaya. From literature it is evident that the flora of the Eastern Himalaya in general and that of Nepal in particular (21) incorporates the Geraniaceae in the form of *Geranium* only. On the contrary, three, viz. *Biebersteinia, Erodium* and *Geranium* are recorded from high altitudes of West Himalaya (19). *Erodium tibetanum* was discovered from Rupshu (4500 m) while *Biebersteinia odora* was collected from Ladakh (5100 m) and Lahul (4800 m).

Geranium is a very coloueful herb with handsome foliage and beautiful flowers. Its species are valued as garden and greenhouse ornamentals. Moreover, *G. nepalense* is an astringent and used in renal disorders (22). Some species of *Pelargonium* (*P. capitatum, P. graveolens* etc.) are grown in Darjeeling as pot herbs. These are also a source of Geraniol, an eugenol which is used in soap and perfume industries.

All the five species recorded in the present work are Himalayan in origin and their dispersion extends upto South Tibet in case of *G. donianum* and *G. lamberti* and further upto North Burma, North Indochina and West China and Nilgiri Hills in South India in case of *G. nepalense*. The most frequently met species is *G. nepalense* which, though cold loving like the rest, shares with *G. polyanthes* the adaptability to relatively warmer conditions prevailing in lower elevations of the Himalaya and Assam. Furthermore, *G. nakaonum* and wallichianum are likely to be detected in the temperate regions of Darjeeling Himalaya since they are known to exist in adjoining areas of Nepal and Bhutan (21). So may be the case with *G. procurrens* which was reported from Sikkim and Nepal by Yeo (23). The present endeavour detects *G. refractum* as a new record for West Bengal.

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VUJBS 2 : 30-39, 1996

Molluscan Biodiversity of the Freshwater Wetlands of Midnapore District

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Abstract

The paper reports 15 forms of freshwater molluses, from Midnapore disctrict, of these 3 species, viz., *Thiara (Tarebia) lineata* (Gray), *Thiara (Tarebia) granifera* (Lamarck), *Thiara (Melanoides) tuberculata* (Muellerr) and one form viz., *Bellamya bengalensis* f. *dolians* (Gould) have been recorded here for the first time from this district. Quotient of similarity between the wetlands have been analysed.

Introduction

India belongs to one of the top 12 megadiversity countries. Molluscs are very much important from the point of view of biodiversity, sharing almost every possible habitat, terrestrial, aquatic and even arboreal. These constitute important components of the food web in an ecosystem. 200 species of fresh water molluscs under 57 genera and 21 families are reported from India, of which 47 species are commonly encountered (1). The diversity in West Bengal is represented by 52 species, under 25 genera and 14 families (2). Of these, only 10 species under 8 genera and 8 families are known from Midnapore, the largest district. The present paper is based on the findings of three wetlands in the district.

Material And Method

Three wetlands, selected for the present investigation, are situated at Pirrakata-Bara Bundh (22° 33' N, 87° 11' E, Site-I), Gangadashpur- Gangadashpur Bundh (22° 33' N, 87° 07.75' E, Site-II), and at Midnapore town- Rajar Dighee (22° 27' N, 87° 20' E, Site-III). Site-I is a natural or unmanaged, Site-II is a partially managed and site-III is a managed wetland. Specimens were collected at monthly intervals from 4.2.95 to 17.2.96 from the three sites. The quotient of similarity between the sites on the basis of molluscan diversity was also measured following Sorensen (3).

Systematic Account

Phylum - Mollusca
Class - Gastropoda
Sub-class - Prosobranchia
Order - Mesogastropoda
Family - Viviparidae
Sub-Family - Bellamyinae.

Bellamya Jousseaume, 1886

1886-Bull. Soc. Zool. France, II : 478

+ Corresponding Author

(1) *Bellamya bengalensis* f. *typica* (Lamarck, 1822)

1822 - *Paludina bengalensis* Lamarck

Hist. Nat. Anim. Sans. Vert., 6(2) : 174

1980 - *Bellamya bengalensis* f. *typica* Subba Rao, Das & Mitra

Rec. Zool.Surv. India, 77 : 228.

1992 - Fauna of West Bengal, Part-9 : P-12

Material Examined

4 exs. site-I, 18.2.95; 5 exs. site-I 8.4.95; 12 exs. site-I, 16.8.95; 9 exs. site-I, 16.9.95; 10 exs. site-I 19.10.95; 2 exs. site-I, 15.11.95; 3 exs. site-I, 13.12.95; 1 exs. site-I, 17.2.96; 5 exs. site-II, 18.2.95; 1 exs. site-II 8.4.95; 14 exs. site-II, 16.8.95; 8 exs. site-II, 16.9.95; 11 exs. site-II, 20.10.95; 3 exs.. site-II, 16..11.95; 2 exs. site-III, 16.4.95; 3 exs. site-III, 9.4.95;

Distribution

West Bengal - South 24 pgs., Calcutta, Midnapore, Purulia, Hoogly, Nadia.
India - Commmon throughout.
Outside India - Bangladesh, Burma, Sri Lanka.
Remark - Oriental in distribution.

(2) *Bellamya bengalensis* f. *doliaris* Gould, 1843

1843 - *Paludina doliaris* Gould.
Proc. Bost. Soc. Nat. hist., 1 : 144.

1992 - Fauna of West Bengal, Part-9 : P-13.

Material Examined

2 exs. site-I, 17.6.95; 1 exs. sitte-I, 15.7.95; 2 exs. site-II, 15.6.95; 2 exs. site-II, 15.7.95.

Distribution

West Bengal - North 24-pgs., South 24 pgs., Birbhum, Purulia, Hoogly, Murshidabad, W. Dinajpur, Cooch Bihar
India - Maharashtra, West Bengal.
Outside india - Burma.
Remarks - Reported here for the first time from Midnapore district. Oriental in distribution.

(3) *Bellamya bengalensis* f. *mandiensis* (Kobelt, 1909)

1909 - *Viviparous bengalensis* f. *mandiensis* Kobelt Martini Chemnitz. Conch. Cab., 2 : 414 pll.. 47, figs. 8-9.

1992 - Fauna of West Bengal, Part-9, p-14

Materials Examined

Nil

Distribution

West Bengal - North 24 pgs., Midnapore (Balichak), Hoogly, Nadia,
India - Bihar, West Bengal, Madhya Pradesh, Uttar pradesh, Gujrat, Punjab, Rajasthan.
Remarks - Commmon throughout Northern India.

(4) *Bellamya dissimilis* (Mueller, 1774)

1774 - *Nerita dissimilis* Mueller
Hist. Verm. Test., pt. 2 : 184
1992 - Fauna of West Bengal, Part-9, p-14

Material Examined

Nil.

Distribution

West Bengal - North 24-pgs., South 24-pgs., Midnapore (Kharagpur), Purulia, Hoogly, Nadia, Murshidabad, W. Dinajpur, Jalpaiguri, Cooch Bihar
India - Common throughout.
Outside India - Bangladesh, Burma, Pakistan, Malayasia, Sri Lanka
Remarks - Oriental in distribution.

Family - Pilidae.

Pila (Bolten) Roeding, 1798
Museum Boltenianum pt. 2, p. 145

(5) *Pila globosa* (Swainson, 1822)

1822 - *Ampullaria globosa* Swainson
Zool. Illustrations Vol.2, pl. cxix.
1925 - *Pila globosa* Prashad
Mem. Indian. Mus., 86 : 70, pl. 13, figs. 1-7,
1992 - Fauna of West Bengal, Part-9, p.15

Material Examined

2 exs. site-I, 16.9.95; 3 exs. site-II, 16.9.95

Distribution

West Bengal - South 24-pgs.,Calcutta, Midnapore, Bankura, Burdwan, Birbhum, Hoogly, Nadia, Murshidabad, W. Dinajpur, Jalpaiguri, Cooch Bihar
India - Common throughout except Punjab, Himachal Pradesh, Southenrn India.
Outside India - Sri Lanka
Remarks - Oriental in distribution.

Family - Bithyniidae

Sub-family - Bithyniinae.

Gabbia Tyron, 1865

Amer. J. Conch., 1 : 216

(6) *Gabbia orcula* var. producta (Nevill, 1884)

1884 - *Bithynia orcula* var. *producta* Nevill.
Hand. List. Moll. India, pt. 2 : 37.

1963 - *Alocinma orcula* var. *producta* Ray and Mukherjee Rec. Zool. Surv. India, 61 : 420, pl. 17, figs.1, 1a.

1992 - Fauna of West Bengal, Part-9, P-17

Material Examined

Nil.

Distribution

West Bengal - South 24-pgs., North 24-pgs., Calcutta, Midnapore (Digha), Birbhum, Hoogly, Howrah, Nadia, Murshidabad

India - Assam, Bihar, West Bengal, Maharashtra, Punjab, Rajasthan, Andhra Pradesh.

Remarks - Endemic in India.

Family - Thiaridae.

Sub-Family - Thiarinae

Thiara Roeding, 1786

Mus. Boltenianum 2 : 109

(7) *Thiara (Thiara) scabra* (Mueller, 1774)

1774 - *Bucccinum scabra* Mueller
Varm. Terr. Fluv. Hist. 2 : 126.

1973 - *Thiara (Thiara) scabra* Pace
Malacological Review Suppl. 1 : 52 pl. 12.

1992 - Fauna of West Bengal, Part-9 p. 19

Material Examined :

Nil.

Distribution :

West Bengal - North 24-Pgs., Calcutta, Midnapore (Balichak), Burdwan, Hoogly.

India - West Bengal, Tamil Nadu, Pondicherry, Madhya Pradesh, Maharashtra.
Outside India - Indonesia, Java, Mauritius, Scychelles, Timor.
Remark - Oriental and Ethiopian in distribution.

(8) *Thiara (Tarebia) lineata* (Gray, 1828)

1828 - Helix lineatus Gray
Woods Index Test. Suppl., p 24, Fig. 68.
1915 - *Thiara (Tarebia)* lineata Preston.
Fauna of British India, Mollusca (Fresh water Gastropoda and Pelecypoda) p 11.
1992 - Fauna of West Bengal Part-9, p.20

Material Examined :

8 exs., site-III, 16.4.95.

Distribution :

West Bengal - North 24-Pgs., South 24-Pgs., Calcutta, Midnapore, Burdwan, Howrah, Hoogly, Nadia, Malda, W.Dinajpur, Cooch Bihar, Darjeeling.
India - West Bengal, Assam, Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra.
Outside India - Bhutan, Burma, Sri Lanka.
Remarks - Oriental in distribution.
Reported here for the first time from Midnapore dist.

(9) *Thiara (Tarebia) granifera* (Lamarck, 1822)

1822 - *Melania granifera* Lamarck.
Hist. Nat. Anim. Sans. Vert 6(2) : 167.
1973 - *Thiara (Tarebia) granifera* Pace
Mal. review. Suppl. 1 : 62
1992 - Fauna of West Bengal, Part-9 p.20

Material Examined :

1 ex. site-III, 16.4.95

Distribution :

West Bengal - North 24-Pgs., Calcutta, Midnapore, Purulia, Birbhum, Hoogly, Nadia.
India - West Bengal, Bihar, Madhya Pradesh, Andaman Nicobar.
Outside India - Burma, Malaysia, Malagasy, Philippines, Formosa, Pacific Islands.
Remarks - Oriental, Ethiopian, Palaearctic (Pantropical) in distribution. Reported here for the first time from Midnapore district.

(10) *Thiara (Melanoides) tuberculata* (Mueller, 1774)

1774 - *Nerita tuberculata* Mueller.
Hist. Vern. Terr. Fluv. 2 :191.

1976 - *Melanoides (Melanoides) tuberculata* Starmuehlner
Am. Natur. Hist. Mus. Wien 86 : 591.

1992 - Fauna of West Bengal, Part-9, p. 19.

Material Examined :

7 exs., sitee-III 16.4.955.

Distribution :

West Bengal - North 24-Pgs., Calcutta, Midnapore, Bankura, Birbhum, Purulia, Burdwan, Howrah, Hoogly, Malda, W. Dinajpur, Jalpaiguri, Darjeeling.

India - Widely distributed except Kashmir.

Outside India - North Africa, Pacific Islands, Australia, China, Japan, Malay Archipelago, South East Asia.

Remarks - Reported here for the first time from Midnapore district. Distributed in Eastern Hemisphere.

Sub-Class - Pulmonata.

Order - Basommatophora

Family - Lymnaeidae.

(11) *Lymnaea* Lamarck, 1799.
Prodr. Nouv. Clas. Coq., p. 75
Lymnaea (Pseudosuccinia) acuminata f. *typica* Lamarck 1822

1822 - *Limnaea acuminata* Lamarck
Hist. Nat. Anim. Sans. Vert. 6(2) : 160

1925 - *Limnaea acuminata* Annandale and Rao.
Rec. Indian Mus., 27 : 177.

1992 - Fauna of West Bengal, Part-9, P. 22.

Material Examined

4 exs., site-I, 18.2.95; 3 exs., site-I, 16.8.95; 5 exs., site-I, 16.9.95; 8 exs., site-I, 19.10.95; 9 exs. site-I, 15.11.95; 12 exs. site-I, 13.12.95; 6 exs., site-I, 2.96; 2 exs., site-II, 16.8.95; 5 exs., site-II, 16.9.95; 9 exs. site-II, 20.10.95; 10 exs. site-II 16.11.95

Distribution :

West Bengal - Calcutta, Midnapore, Bankura, Birbhum, Purulia, Howrah, Nadia, W. Dinajpur, Cooch Bihar, Jalpaiguri.

India - Widely distributed

Outside India - Bangladash, Pakistan.
Remarks - Oriental in distribution.

(12) *Lymnaea (Pseudosuccinia) luteola* f. australis Annandale & Rao
1925 - *Limnaea (Pseudosuccinia) luteola* f. *australis* Annandale & Rao.
1992 - Fauna of West Bengal, Part-9, p.24.

Material Examined :

Nil.

Distribution :

West Bengal - South 24-Pgs., Calcutta, Midnapore, Burdwan, Purulia, Hoogly, Nadia, W. Dinajpur.
India - Common throughout.
Outside India - Pakistan, Bangladesh, Burma
Remarks - Oriental in Distribution

Family - Planorbidae

(13) *Indoplanorbis* Annandale & Prashad, 1921
Rec. Indian Mus. 22(4) : 578
Indoplanoribis exustus (Deshayes, 1834)

1834 - *Planorbis exustus* Deshayes
Vay. Belang. Indo. Orient. Zool., P.414, pl.1, figs. 11-13,
1921 - *Indoplanorbis exustus* Annandale & Prashad.
Rec. Indian Mus., 22 : 472
1992 - Fauna of West Bengal, Part-9 p.25.

Material Examined :

4 exs. site-I, 18.2.95; 7 exs. site-I, 16.8.95; 6 exs. site-I, 16.9.95; 4 exs. site-I, 19.10.95; 4 exs. site-I, 15.11.95; 1. site-I 13.12.95; 2 exs. site-I, 17.2.96; 8 exs. site-II, 16.8.95; 5 exs. site-II 16.9.95; 5 exs. site-II, 20.10.95; 4 exs. site-II, 16.11.95 4 exs. site-III 29.8.95.

Material Examined :

Distribution :

West Bengal - South 24-Pgs., Calcutta, Midnapore, Bankura, Burdwan, Birbhum, Nadia, W. Dinajpur, Malda, Cooch Bihar, Jalpaiguri.
India - Widely distributed.
Outside India - Pakistan, Sri Lanka, Bangladesh, Burma, Malay Peninsula,Tibet, Iran.
Remarks - Oriental and Palaearctic in distribution.

Class - Bivalvia
Order - Unionida
Family - Unionidae
Lamellidens Simpson, 1900
Proc. U. S. Natu. Mus. (Washington) 22 : 854

(14) *Lamellidens marginalis* (Lamarck, 1819)

1819 - *Unio marginalis* Lamarck
Hist. Nat. Anim. Sans. Vert., 6 : 79.
1900 - *Lamellidens marginalis* Simpson
Proc. U. S. Natu. Mus., 22 : 854.
1921 - *Lamellidens marginalis* Prashad
Rec. Indian Mus., 22 : 606 fig. 29 A.
1992 - Fauna of West Bengal, Part-9, p.29

Material Examined :

1 ex. site-II, 18.2.95.

Distribution :

West Bengal - Calcutta, Midnapore, Bankura, Burdwan, Nadia, Malda, Jalpaiguri, Cooch Bihar.
India - Widely distributed.
Outside India - Sri Lanka, Burma,Bangladesh.
Remarks - Oriental in distribution.

order - Veneroida
Family - Corbiculidae
Corbicula Meerle Von Mueh1feid, 1811
Mag. Gesell. Naturf. Berlin., 5 : 56

(15) *Corbicula straitella* Deshayes, 1854

1854 - *Corbicula striatella* Deshayes.
Proc. Zool. Soc. Lond., 4.344
1928 - *Corbucula striatella* Prashad
Mem. Indian. Mus., 18, pl-3, figs. 9-11,
1992 - Fauna of West Bengal, Part-9, P-34

Material Examined

Nil

Distribution

West Bengal - North 24-pgs., Calcutta, Midnapore, Bankura,Hoogly, Nadia, W. Dinajpur, Cooch Bihar.

India - Common throughout.

Outside India - Burma, Pakistan, Peshwar, Sindh.

Remarks - Oriental in distribution.

Discussion :

The molluscan biodiversity in Midnapore district is represented by 15 forms, belonging to 13 species and 8 genera and 8 families. Of these 1 form and 5 species have been reported from literature and 8 species and1 form have been recorded on the basis of the findings of the present study. 3 species and 1 form are reported here for the first time, from Midnapore district. Three sites have 5, 6 and 5 forms respectively (Table-I). A comparison of the Q/S value (Table-II) reveals that site-I & II are strongly similar in faunal composition and site-III is strongly dissimlar from both these sites. The faunal similarity between sites I and II may be attributed to the proximity and unmanaged nature of the sites. Site III is located at some distance from the other sites and is subjected to greater anthropogenic interference. This might be the cause of the strong faunal dissimilarity.

Table–I
MOLLUSCAN FORMS RECORDED FROM THE WET LANDS.

		Site-I	Site-II	Site-III
1)	*Bellamya bengalensis* f. *typica*	+	+	+
2)	*Bellamya bengalensis* f. *doliaris*	+	+	–
3)	*Pila globosa*	+	+	–
4)	*Lymnaea acuminata* f. *typica*	+	+	–
5)	*Indoplanorbis exustus*	+	+	+
6)	*Thiara (Tarebia) lineata*	–	–	+
7)	*Thiara (Tarebia) granifera*	–	–	+
8)	*Thiara (Melanoides) melanoides*	–	–	+
9)	*Lamellidens marginalis*	–	+	–
	Total	5	6	5

Table – II
SORENSEN'S QUOTIENT OF SIMILARITY BETWEEN SITES

SITES	I	II	III
I	X	90	40
II		X	36
III			X

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A Reconnaissance Survey of Recent Benthic Foraminifera From The Mangrove-Estuarine Sector of Indian Sundarbans

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Abstract

A reconnaissance biocoenose survey of recent, benthic foraminifera from the mangrove-estuarine sector of Indian Sundarbans was carried out to generate baseline information from this fragile biotope. Thirty one species of recent benthic foraminifera belonging to 17 genera under 11 families and 4 suborders were identified and reported for the first time. *Ammobaculites agglutinans, A. americanus, A. exiguus, Ammonia beccarii, A. tepida, Arenoparella mexicana,Cribroelphidium poeyanum, Cribrostomoides jeffreysii, Haplophragmoides canariensis, Miliammina fusca* and *Trochammina inflata* were found endemic to the study area.

Key Words : Biocoenose, Recent, Benthic, Foraminifera, Mangrove, Sundarbans.

The foraminifera are unicellular, pore bearing, shelled, protists belonging to Subkingdom-Protozoa (1), under the Phylum-SARCOMASTIGOPHORA Honiberg & Balamuth, 1963, Subphylum-SARCODINA Schmarda, 1871, Super class - RHIZOPADA von-Siebold, 1845, Class - GRANULORETICULOSEA (De Saedeleer, 1934) and Order - FORAMINIFERIDA D'Orbigny, 1826. They are now placed under 12 sub orders, 74 superfamilies, 296 families and 302 subfamilies (2), containing about 2667 valid genera till to date (3).

Information on recent benthic foraminifera from the mangrove-estuarine environment of the Indian coast is very inadequate. The brackishwater foraminifera has manifold applied utility (4,5). The present environment of rapid industrialisation, mushrooming of aqua-farm in the coastal zone and mass scale conversion of agricultural land into aquacultural area in the Sundarbans are bound to alter the hyrobiological scenario of this fragile biotope in the near future. In view of the above stated situations a reconnaissance biocoenose study of recent benthic foraminifera has been carried out by analysing the sediment samples of 1989-'90 following standard analytical techniques (6) in some selected areas of the mangrove estuarine sector of deltaic Sunndarbans, India. (21°29'N to 21°45'N latitude and 87° 29'E to 88° 38'E longitude). Three sectors,viz. S_{i}, S_{ii} & S_{iii} were surveyed along the three rivers Matla, Saptamukhi & Hooghly respectively (from a depth range of intertidal to 14M. depth) for generating baseline information to assess the future temporal variations in this area, part of one of the world's greatest deltas (7,8).

Method

Sediment samples were collected by means of a Van Veen Grab sampler. Five samples were collected randomly from each site, the top one cm. of each of the samples were removed and mixed

+ Corresponding Author

thoroughly to prepare a composite sample. Finally, one fifth of this composite sample was taken for foraminiferal analysis following wet sieving and floatation technique (9). Rose Bengal solution was used to differentiate the living from the dead ones (10,11,12).

Results

All together 31 species of recent benthic foraminifera belonging to 17 genera under 11 families & 4suborders & 4suborders were identified and recorded for the first time from the study area.

A list of the recorded foraminiferal species is given hereunder (Generic names are in accordance with Loeblich & Tappan, 1988) (13).

Ammobaculites agglutinans (d'Orbigny)+
A. americanus Cushman+
A. exiguus Cushman & Bronnnimann+
Ammonia beccarii (Linne)+
A. tepida (Cushman)+
Arenoparrella mexicana (Kornfeld)+
Asterorotalia dentata (Parker & Jones)
A. inflata (Millett)[D]
A. multispinosa (Nakumara)
A. trispinosa (Thalmann)
Bolivina striatula (Cushman)
B. Sp.[D]
Brizalina spathulata (Williamson)[D]
Cribroelphidium poeyanum (d'Orbigny)+
Cribrostomoides jeffreysi (Williamson)+
Elphidium advenum (Cushman)
E. crispum (Linne)
E. discoidale var. multiloculum (Cushman & Ellisor)
E. hispidulum (Cushman)
E. incertum (Williamson)
E. somaense (Takayanagi)
Haplophragmoides canariensis (d'Orbigny)+
Miliammina fusca (Brady)+
Nonionellina labradorica (Dawson)[D]
N. turgida (Willamson)
Pseudononion cf. P. japonicus (Uchio)[D]
Quinqueloculina seminulum (Linne)
Q. vulgaris (d'Orbigny)
Reophax dentaliniformes Brady.
Triloculina brevidentata (Cushman)
Trochammina inflata (Montagu)+

+ marked forms are endemic to the stuudy area.

[D] marked forms were found only in dead condition.

Discussion :

This is the first biocoenose study of recent, benthic foraminifera from this part of the tropical world. The endemic forms are mostly euryhaline and hence better adapted to withstand the vivratory

environment which is under semidiurnal tidal influence. Beside some of the nearshore forms have also invaded the estuary and are able to colonize the area with a fair degree of success. The forams that never encountered in living condition are mostly the product of post-mortem transport. The faunal assemblage corroborates with that of the typical hypohaline marginal marine environment. Zoogeographically, the forams belong to Indo-Pacific province.

The sectors adjacent to the River Matla & River Saptamukhi represent typical mangrove environment dominated by mangroves like *Avicennia alba, A. officinalis, Ceriops decandra, Bruguiera gymnorrhiza, Rhizophora apiculata, R. murconata* etc. Luxuriant growth of estuarine grass Porteresia coarctata is also noticed in the mid littoral zone (7,8). The sediments of these sites are mostly clayey-silt in nature. The population density was quite low in the estuarine channel, whereas moderate densities were observed in exposed, intertidal, algal rich mangrove mud flats. On the other hand, the sector beside River Hooghly is devoid of rich mangroves. It is characterised by huge suspended particulate matter, limnetic condition, strong downstream discharge, unstable sedimentary facies dominated by sandy sediments. Poor faunal density, diversity & ill health reflect the ecological inhospitability of the sector.

This set of information may well act as a base line information in the near future to assess the temporal variability in view of over increasing pollution load in the Hooghly -Matla estuarine complex.

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Toxonomic Notes :

Taxa are arranged in alphabetical order. Under each species the original reference is included and for many a taxa more recent, and significant available references are added.

Ammobaculites agglutinans (D'Orbigny)

Spirolina agglutinans D'ORBIGNY, 1846, Foram. Res. Vol. 24, pt.2 p.39, pl.7, figs. 10, 11.

***Ammobaculites americanus* Cushman**

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Biochemical and Haematological Changes in Rheumatoid Arthritis Patients

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Abstract

Rheumatoid Arthritis is a common form of chronic inflammatory and autoimmune disease. The possible changes in different metabolites in blood of rheumatoid patients have been investigated and compared with normal subjects. Serum uric acid level was found to be much higher in rheumatic patients (8.56 + 0.88) compared to normal subjects (2.97+0.95). But concentration remained significantly lower in rheumatic patients when compared to normal persons. In these patients neutrophils, monocytes, lymphocytes and total counts of leucocytes had sharply decreased. No significant changes were noted in Eosinophils, Basophils counts and level of blood creatinine, urea and serum protein concentration.

Key-Words :- Autoimmune disease.

INTRODUCTION

Rheumatoid Arthritis is an autoimmune disease which causes inflammation of one or more joints. It is caused by an antibody, generally of IgM class against host antigen. The disease is characterised by swelling, redness of the overlying skin, pain on the joint and restricted motion. Rheumatoid factor is specific for a determinant on the Fc portions of the patients owning IgG molecules. The complexes between rheumatoid factor and IgG deposit in the synovial space (I).

Though this disease mainly affects immune system, it also causes changes in metabolic system. Haemostasis is also affected by this disease. Anaemia is associated due to iron deficiency with chronic inflammatory disease (2). Lymphocyte content and their functional activity are also depressed (3). Monocyte level and their functional capacity are not correlated with rheumatoid factor (4). Among the metabolites serum urate might increase, which plays an antioxidant role under certain conditions in this disease (5). Present investigation proposes to study the metabolites level in blood of patients affected with Rheumatoid arthritis. It also reveals the level of different leukocytes in arthritic condition in comparison with normal counterpart.

Materials And Methods

Blood samples were collected from arthritic patients and normal individuals and the patients aged 20-40 years of both sexes. Serum uric acid was measured by cyanide free method (6); blood urea was measured by DAM method (6) and the total serum protein was measured by Lowry method (7). Haemoglobin level was estimated by Shallis method. The total leukocyte count was done by Neubaure haemocytometer.

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Results:

Table 1. *Concentration of Metebolites in blood of normal and Rheumatoid Arthritic patients. (Mean ± SD)*

Parameters	Male		Female	
	Normal	Rheumatic	Normal	Rheumatic
SERUM URIC ACID (mg%)	2.97±0.95	8.56±0.88 *	4.11±1.09	8.79±0.92 *
BLOOD CREATININE (mg%)	1.90±0.95	1.40±0.69	1.20±0.67	1.40±0.76
BLOOD UREA (mg%)	31.00±5.19	31.10±6.32	32.10±7.79	34.30±5.74
SERUM PROTEIN (gm%)	7.11±1.10	6.70±1.31	7.34±1.10	7.00±1.16
Hb. Conc. (gm%)	13.83±1.15	11.3±1.23 **	12.8±1.52	9.52±1.00 ***

* P < 0.001
** P < 0.01
*** P < 0.05

Serum uric acid and protein, blood creatinine, urea and Hb conc. were estimated and compared between normal and RA patients. Results of both male and female groups are shown in Table-I. Serum uric acid level sharply increased in RA patients in comparison to normal subjucts. Blood creatinine, urea and Serum protein conc. remained similar in both the groups. Haemoglobin cencentration was found to be lower in RA patients.

Table 2. *Comparison of differential count and Total count of Leucocyte in Normal and Rheumatoied Arthritis patients. (Mean ± SD)*

Parameters	Male		Female	
	Normal	Rheumatic	Normal	Rheumatic
NEUTROPHIL (%)	62.0± 6.1	53.0± 8.8 *	60.3± 3.87	51.7± 5.95 *
EOSINOPHIL (%)	5.3± 2.76	4.2± 1.4	4.6± 2.01	4.4± 2.11
BASOPHIL (%)	0.7± 0.9	0.5± 0.8	0.3± 0.64	0.5± 0.8
MONOCYTE (%)	6.1± 2.98	2.7± 2.49	7.6± 2.49	3.9± 1.76
LYMPHOCYTE (%)	33.8± 4.69	30.4± 6.73 **	31.2± 3.71	28.7± 4.86 **
TOTAL COUNT OF LEUCOCYTES (per cu.mm.)	7330±958.44	5710±732.73 *	7425.6±839.5	5855±711.5 *

* P < 0.05
** P < 0.01

Differential and total count of leucocytes were done with the blood of RA patients and normal subjects. Results of both male and female groups are shown in Table 2. A significant reduction of neutrophil, monocyte and total leucocyte count was found in RA patients. But no significant changes were noted in eosinophil and basophil counts.

Discussion

Results of the present study showed that there were significant changes in serum urate level in arthritic male and female patients compared to normal individuals. The changes in urate level might be due to endogenous purine metabolism as pathogenesis results in muscle wasting and cellular degradation. Blood urea and creatinine level showed no significant change between the study groups. These results indicated that possibly liver function was not affected to a great extent in the production of urea and creatinine. Serum protein level changes showed insignificant result which partly supports the insignificant change of blood urea level.

Haematological responses indicated that there was significant reduction of haemoglobin level. It causes anaemia. Anaemia might have also been produced by ascorbate deficiency as its concentration as well as oxidation-reduction equilibrium were lowered in rheumatoid arthritic condition. Erythropoiesis impairment might be another cause of anaemia mediated by tumomnecrosis factor in this condition (3).

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Some Aspects of Anthropometry and Demography of the Kora-Mudi in the District of Midnapore, West-Bengal

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Abstract

The present paper deals with nine anthropometric characters, fertility history and child mortality of the Kora-Mudi ethnic group in the district of Midnapore. The anthropometric characters of 314 individuals have been taken following the standard techniques. Distance curves of four anthropometric characters and four indices as well as velocity curves of four anthropometric characters do not show seculer trend with the advent of age but are indicative of sexual-dimorphism. The sex ratio of the total population and the children born out of ever-pregnant mothers show that the survivality of the female is greater than the male.

Key-Words : Anthropometry, age change, sexual dimorphism, demography, sex ratio.

Introduction

Eversince the decline of the debate on race and racial classification, the studies on human growth took the centre stage in anthropometry. The study on sexual dimorphism and age-changes in different anthropometric traits help to identify the factors affecting the growth in various stages of life in different ethnic groups and their adaptibility to different environmental condition including the social cultural situation (1, 2, 3). Despite the application value of the demographic study, it offers some lively theoretical discusions on sex ratio. The importance of sex ratio, particularly of live births, in anthropology is due to its value as indicator of mutation, selection, migration, and other processes of micro-evolution (4, 5).

The objective of the present study is to present the collected data on some aspects of anthropometry and demography of the Kora-Mudi ethnic group. The biological aspect of this community has not been published so far. There is an urgent need to study this small ethnic group as they are coming in contact with new emerging economy through the introduction of industry which may affect their bio-cultural characters.

Materials and Methods

1. Anthropometry:

The Kora-Mudi represents a small branch of Mundari speaking tribal community of Kora having a restricted distribution in West Bengal and Bihar. Originally they hail from Chhhotonagpur which was their traditional homeland. In West Bengal, according to the 1961 Census, the Kora population numbers 62, 029 constituting about 3% of the total tribal population of the state.

The present study has been undertaken among the Kora-Mudi of a multi-ethnic village called Paschim Amba under Kharagpur (local) police station in the district of Midnapore. The ancestors

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of the present day Kora-Mudi villagers immigrated here some 70 years ago from an unknown area to work as agricultural labourer. Currently, among 351 Kora-Mudi people of the village (enumerated through standard census schedule), 176 (50.58) are males and 175 (49.85%) are females. From the economic point of view, most of them, irrespective of sex, are day labourers and have acquired the necessary skill in earth-work such as digging pond, making embankment.

Measurements on nine anthropometric characters-stature, weight, height acromion, height iliocrystal, anterior-posterior chest, transverse chest, biacromial breadth, biiliocrystal breadth, Upper arm circumference have been taken following the standard techniques (6). Absolute measurements, taken on both males and females, are in centimeter excepting the weight which is in kilogram.

The anthropometric traits are based on a sample of 314 individuals (154 males and 160 females) from both the sexes ranging from 0-70^{+} years and are presented in age cohorts 0-4, 5-9, 10-14 respectively. The study on sexual dimorphism and age-change with respect to anthropometric characters as well as cross-sectional growth velocity are made on a sample of 154 individuals (68 males and 86 females) ranging from 18 to 70^{+} years. The collected data have been classified into six age cohorts with an interval of ten years excepting the first and the last one ranging from 18-20 and 60-70^{+} years.

To estimate the sexual dismorphism in eight anthropometric traits, t-test has been done. For this purpose, a sample of 63 males and 76 females (altogether 139 individuals) ranging from 20 to 70+ years has been taken by clubbing them on the basis of sex. This technique removes the instrumental error, increases the sample size and reduces the internal differentiation in the anthropometric value for both the sexes belonging to different age cohorts.

2. Demography:

To collect the demographic data, 67 ever-pregnant women out of 91 ever married women have been interviewed. Since both the sexes of the community are wage-earners, the interview has been carried on whosoever is available in the village at the time of field-work. In this way, it is hoped, the bias of the interviewer has automatically been reduced to indicate trend in the fertility pattern. The data have been collected on the basis of the standard fertility history schedule pointing out the mother's present age, order of pregnancies and births (mentioning live-births, still births and abortion), sex of the children, mother's age at the time of birth, present age of the live children as well as age at the time of death, duration of breast feeding, age at weaning, contraception used (if any) and menopausal age.

For analysis, the ever-pregnant mothers have been categorized into three age cohorts such as 15-49, 50-70+ and all ages. Sex ratio of the live-births and still-births has also been calculated. To calculate the mortality by age and sex, the dead children have been categorized into four age cohorts with an interval of four years, such as 0-4, 5-9 etc.

This section remains incomplete until the limitations are stated. As in most other cases, ascertaining cornect age of the Kora-Mudi is a problem. Rarely they visit maternity homes and consequently there is no record of their age. There is no scope to apply other ways of determining correctly the ages of the individuals. The referred age in the text is approximate as stated by the individuals themselves.

Results

1. Anthropometry :

Age and sexwise mean value of all the anthropometric measurements are presented in table 2. Quantitative assessment of sexual dimorphism with the progress of age is shown in tables 4 to 7 whereas table 3 shows the age-cohorts and sample size. The quantitative assessment of the effects of age-changes on the sexes have been done on four anthropometric characters namely, stature, weight, biacromion breadth and iliocrystal breadth and are given in tables 8 to 11.

The distance curve (Fig. 1) shows marked difference between the sex excepting the relative shoulder breadth (shoulder hip) index. In case of the stature, the male values begin to decline after 30 years of age and gain a little after 41. The female values decline a little after 41 years and remain steady till the end of life. The weight gains for the male is negligible from 18 years onward and declines a little after 50 years. The same is the case with the females, but the declining trend starts early at the age of 41 and again shows an upward trend after 61 years. For biacromion breadth, the change of values for both the sexes is almost negligible. But the biacromion breadth index shows a declining trend for both the sexes with the advancement of age. In the case of males, the decline starts after 50 years but it does so early in the case of females, at the age of 40 years, to be precise. 18 years onward, the biiliocrystal breadth of the males gains a little till 40 years and then sharply declines until 50 years. As for the female the upward trend continues throughout the life. The increase is faster till 40 years and then becomes slow and negligible. The biiliocrystal breadth index not only shows higher values for the females but the continuous upward trend with varying degrees at various ages. For the same index, the male value begins to increase after 21 years, at 51 years goes, again after 60 years. The sexual dimorphism is not clearly marked in case of shoulder breadth index where the male gains a little between 51 to 60 years of age. In shoulder pelvic index, the values for the females are always greater than the males and show a continuous upward trend with varying degrees. The male starts with a higher value but gradually declines, to a maximum at the age of 60 years, and then goes upward.

The velocity curves of stature, weight, biacromion breadth and biiliocrystal breadth (Fig. 2) show a zig-zag trend and nothing can be concluded in particular.

The t-test with two independent samples of males and females shows significant sexual dimorphism in anthropometric traits with a value: $t(137) = p < 0.01$, two tailed, excepting biiliocrystal breadth and transverse chest (Table 12).

2. Demography :

A glance at the age and sex-wise distribution of the Kora-Mudi population (Table 1) shows that the number of individuals decreases with the advancement of age. It may be interpreted as the outcome of a high fertility rate and similarly a high mortality rate in the population. If the sexwise distribution of the population is taken into account, the male mortality is higher than the females. Though it was not possible to interview all the ever married women of the village, the fertility history of the interviewed 67 women shows a definitive trend. Among the children, surviving and dead, the sex-ratio tilts in favour of the females (Table 13). The chances of survival for the male child is greater in early ages which gradually goes down with the increasing age (Table 15). The number of children per mother cannot be considered as high (Table 14) if the early marital age is considered. There may be other social-cultural factors behind the conception of mothers which have not been investigated.

Discussion

The irregular fluctuations in velocity curves (Fig. 2) may raise a question regarding the inadequate sample at the age-groups of 18-20, 51-60, and 61-70+ for the males, and at the age group of 41-50 and 51-60 for the females. This inadequate sample might have popped up the mean value hinders the correct results. It would have been true if the curves are consistent for both the sexes. Fig. 1 shows that negligible changes occur in both the sexes among the aged persons in case of bi-acromion breadth and shoulder breadth index. But in case of shoulder-pelvic and bi-illiocrystal breadth indices the male values go up at the late age (61-70)+ expectedly due to poor sample number, the values for the female in the same age cohort also show an upward trend despite having a considerble number of individuals. So, it may not be the sample number but other factors which are responsible for such fluctuation in the curves. Further research is needed in this regard.

In demography, it is observed that the children of both sexes are more or less equal in number (Table 1 and Table 13). But the chances of survival for the female children are more than the male children after 4 years of age. This is also observable in case of the adult and aged females because aged females are more in number than the males (Table 1).

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Table : 1 KORA POPULATION BY AGE, SEX AND MARITAL STATUS.

Age Group (Years)	Unmarried		Married		Widow (er)		Total	
	M	F	M	F	M	F	M	F
0-4	25	25					25	25
5-9	28	26					28	26
10-14	29	24					29	24
0-14	82	75					157	
							Sr 1.09	
15-19	14	5	2	12			16	17
20-24	6	3	9	11		1	15	15
25-29	2	1	11	20	1		14	21
30-34			13	5		1	13	7
35-39			12	10			12	10
40-44			4	4			4	4
45-49			8	8			8	8
15-49	22	9	59	70	1	3*	164*	
							SR 1.0	
50-54			6				6	
55-59			5	1		1	5	2
60-64				4		4	-	8
65-69				2	1	1	1	3
70+				3		2	-	5
50-70+			11	10	1	8	30	
							SR 0.67	
Total	104	84	70	80	2	11*	151	
							SR 1.01	

*Including 1 female divorcee at the age-group 30-34.

SR = Sex Ratio (m/f)

Table : 2 MEAN VALUE OF THE MEASUREMENTS

Age Group	0 - 4		5 - 9		10 - 14		15 - 19		20 - 24	
Sex	M	F	M	F	M	F	M	F	M	F
SAMPLE NUMBER (N)	23	23	28	23	27	23	13	17	15	12
STATURE (cm.)	84.05	82.83	111.84	112.13	129.27	127.5	150.76	149.9	160.3	148.47
BIACROMION BREADTH (cm.)	19.41	17.92	23.86	23.97	28.47	27.36	31.91	32.5	36.5	31.58
HEIGHT ACROMION (cm.)	64.10	63.00	89.01	86.45	99.9	99.32	122.0	122.8	130.84	121.05
HEIGHT ILIOCRYSTAL (cm.)	43.96	42.62	62.99	64.66	75.54	72.56	88.18	92.88	88.85	82.17
TRANSVCE CHEST (cm)	15.42	14.47	18.88	17.80	19.22	19.71	22.63	23.18	26.06	25.34
ANTERIOR & POSTIRIOR CHEST (cm.)	11.54	11.57	13.03	12.69	14.31	13.86	16.36	15.65	17.68	16.36
BIILIOCRYSTAL BREADTH (cm.)	13.80	13.64	17.06	17.05	19.83	19.98	23.1	24.22	25.01	23.94
ARMCIRCUM-FERENCE (cm.) (Left)	13.0	12.75	14.45	14.11	16.82	16.81	20.24	21.07	23.62	21.11
ARMCIRCUM-FERENCE (cm.) (Right)	13.00	12.75	14.44	14.11	16.94	16.66	20.44	21.12	23.61	21.19
WEIGHT (kg)	9.76	9.12	16.71	16.84	24.75	24.92	38.76	38.77	46.61	37.95

Table : 2 (Contd.)

Age Group	25 - 29		30 - 34		35 - 39		40 - 44		45 - 49	
Sex	M	F	M	F	M	F	M	F	M	F
SAMPLE NUMBER (N)	9	19	10	7	7	10	4	4	7	8
STATURE (cm.)	159.73	148.22	161.0	140.0	158.08	149.79	158.08	145.80	156.11	146.77
BIACROMION BREADTH (cm.)	36.3	32.17	35.97	30.65	35.98	32.55	36.80	32.40	35.05	31.48
HEIGHT ACROMION (cm.)	129.68	121.33	132.59	119.95	132.10	114.33	129.58	116.26	128.58	120.6
HEIGHT ILIOCRYSTAL (cm.)	91.73	87.35	95.34	86.0	95.55	86.04	93.32	85.5	91.47	86.80
TRANSVCE CHEST (cm)	25.46	24.96	24.90	33.86	25.38	24.37	25.16	23.04	23.7	822.64
ANTERIOR & POSTIRIOR CHEST (cm.)	17.36	16.65	17.51	15.48	17.65	16.12	17.34	15.28	18.18	16.12
BIILIOCRYSTAL BREADTH (cm.)	25.02	24.60	25.41	24.46	24.88	24.99	25.16	25.02	25.02	25.12
ARMCIRCUM-FERENCE (cm.) (Left)	23.30	21.50	22.17	20.73	24.11	21.80	24.10	22.46	23.72	21.88
ARMCIRCUM-FERENCE (cm.) (Right)	23.15	21.63	22.38	20.90	24.18	21.85	24.34	22.54	23.83	22.05
WEIGHT (kg)	45.18	39.31	44.25	35.67	47.78	41.08	46.30	37.58	49.21	37.78

Table : 2 (Contd.)

Age-group	50 - 54		55 - 59		60 - 64		65 - 69		70 +	
Sex	M	F	M	F	M	F	M	F	M	F
SAMPLE NUMBER (N)	5	0	5	2	0	6	1	3	0	5
STATURE (cm.)	154.37		158.68	151.55		141.24	157.0	144.06		146.33
BIACROMION BREADTH (cm.)	35.9		35.82	33.35		29.98	35.0	29.0		31.58
HEIGHT ACROMION (cm.)	125.65		131.1	128.60		115.66	130.1	118.13		120.2
HEIGHT ILIOCRYSTAL (cm.)	90.27		96.30	89.80		84.96	91.2	85.8		86.93
TRANSVCE CHEST (cm)	24.95		23.82	24.4		21.96	25.5	21.66		22.28
ANTERIOR & POSTIRIOR CHEST (cm.)	17.82		19.72	15.75		15.16	17.0	16.73		16.80
BIILIOCRYSTAL BREADTH (cm.)	25.92		23.86	25.4		24.26	26.5	25.9		25.42
ARMCIRCUM-FERENCE (cm.) (Left)	23.05		21.96	21.75		19.13	20.0	20.93		19.88
ARMCIRCUM-FERENCE (cm. (Right)	22.9		21.84	21.0		19.07	20.2	20.96		19.86
WEIGHT (kg)	45.75		42.9	38.50		35.91	40.0	39.33		32.7

Table : 3 RELATION BETWEEN AGE GROUP NUMBER AND MEAN AGE

Age Group Number	Age Range	Male		Female	
		No. of Individual	Mean age	No.of Individual	Mean age
I	18-20	6	18.83	12	18.25
II	21-30	29	25.24	32	25.81
III	31-40	14	35.71	18	36.27
IV	41-50	12	46.08	8	44.87
V	51-60	6	55.0	5	59.0
VI	61-70+	1	65.0	11	68.72

Table : 4 BIACROMION BREADTH INDEX

Age Group Number	MALE			FEMALE		
	Mean Stature	Mean Bi-acromion breadth	Index	Mean Stature	Mean Bi-acromion breadth	Index
I	158.1	35.0	22.13	149.1	32.66	21.91
II	160.4	36.37	22.67	147.33	32.03	21.76
III	159.1	35.71	22.44	148.21	32.32	21.80
IV	156.5	35.80	22.87	145.6	31.46	21.60
V	157.3	35.81	22.76	144.76	31.41	21.69
VI	157.0	35	22.29	145.06	30.54	21.05

Table : 5 RELATIVE BIILIOCRYSTAL INDEX

Age Group Number	MALE			FEMALE		
	Mean Bi-illliocrystal breadth	Mean Stature	Index	Mean Bi-illliocrystal breadth	Mean Stature	Index
I	25.0	158.1	15.81	24.25	149.01	16.27
II	25.17	160.4	15.69	24.59	147.33	16.69
III	25.11	159.1	15.78	24.97	148.21	16.84
IV	25.27	156.5	16.14	25.06	145.6	17.21
V	24.08	157.3	15.30	24.98	144.76	17.19
VI	26	157.0	16.56	25.11	145.06	17.31

Table : 6 SHOULDER PELVIC INDEX

Age Group Number	MALE Mean Bi-illliocrystal breadth	MALE Mean Bio-acromion breadth	MALE Index	FEMALE Mean Bi-illliocrystal breadth	FEMALE Mean Bio-acromion breadth	FEMALE Index
I	25.0	35.0	71.42	24.25	32.66	74.24
II	25.17	36.37	69.20	24.59	37.03	76.77
III	25.11	35.71	70.31	24.97	32.32	77.25
IV	25.27	35.80	70.58	25.06	31.46	79.65
V	24.08	35.81	67.04	24.98	31.41	79.50
VI	26	35.0	74.28	25.11	30.54	82.72

Table : 7 SHOULDER HIP RATIO OR RELATIVE SHOULDER BREADTH INDEX

Age Group Number	MALE Mean Bio-acromion breadth	MALE Mean Bi-illliocrystal breadth	MALE Index	FEMALE Mean Bio-acromion breadth	FEMALE Mean Bi-illliocrystal breadth	FEMALE Index
I	35.0	25.0	1.4	32.66	24.25	1.34
II	36.37	25.17	1.44	32.03	24.49	1.30
III	35.71	25.11	1.42	32.32	24.97	1.29
IV	35.80	25.27	1.41	31.46	25.06	1.25
V	38.81	24.08	1.48	31.42	24.98	1.25
VI	35.0	26	1.32	30.54	25.11	1.21

Table : 8 STATURE OF MALES & FEMALES

Age Group Number	Sample No.	Range	Mean+SE	S.D	C.V	Velocity
MALE						
I	6	148.5 – 165.1	158.1 ± 2.30	6.65	4.20	
II	29	146.2 – 169.0	160.4 ± 0.94	5.09	3.17	+ 2.3
III	14	151.0 – 178.0	159.1 ± 1.81	6.79	4.26	- 1.3
IV	12	148.6 – 164.0	156.5 ± 1.51	5.24	3.35	- 2.6
V	6	150.5 – 166.7	158.3 ± 0.44	5.47	3.45	+ 1.8
VI	1	157.0	157 ± 0	–	–	- 1.3
FEMALE						
I	12	139.0 – 160.0	149.01 ± 1.60	5.54	3.71	–
II	32	128.2 – 156.1	147.33 ± 0.97	5.49	3.72	- 1.68
III	18	140.0 – 157.1	148.21 ± 1.36	5.77	3.89	+ 0.88
IV	8	138.1 – 155.0	145.60 ± 1.83	5.18	3.55	- 2.61
V	5	138.6 – 153.1	144.76 ± 2.56	5.73	4.0	- 0.84
Vi	11	139.0 – 158.0	145.06 ± 1.65	5.5	3.78	+ 0.3

Table : 9 WEIGHT OF MALES & FEMALES

M A L E

Age Group Number	Sample No.	Range	Mean-SE	S.D	C.V	Velocity
I	6	54.0 – 41.0	45.66 ± 1.78	4.38	9.6	
II	29	57.5 – 34.0	45.93 ± 1.14	6.16	13.4	+ 0.27
III	14	55.0 – 38.0	46.17 ± 1.40	5.27	11.41	+ 0.24
IV	12	70.0 – 38.5	47.70 ± 2.77	9.61	20.14	+ 1.53
V	6	49.5 – 29.5	44.0 ± 3.36	8.24	18.95	- 3.5
VI	1	44.0	44.0 ± 0	–	–	–
			F E M A L E			
I	12	42.5 – 34.0	38.16 ± 0.96	3.35	8.77	–
II	32	50.0 – 31.0	38.50 ± 0.80	4.56	11.84	+ 0.34
III	18	59.0 – 31.0	39.44 ± 0.67	6.34	16.0	+ 0.94
IV	8	47.0 – 31.5	37.62 ± 1.77	5.03	13.3	- 1.82
V	5	41.0 – 28.0	34.10 ± 2.12	4.75	13.9	- 3.52
Vi	11	44.0 – 27.0	36.68 ± 1.56	5.19	14.14	+ 2.58

Table : 10 BIACROMION BREADTH OF MALES & FEMALES

M A L E

Age Group Number	Sample No.	Range	Mean-SE	S.D	C.V	Velocity
I	6	33.0 – 35.8	35 ± 0.53	1.29	3.6	–
II	29	31.8 – 38.5	36.37 ± 0.32	1.75	4.8	+ 1.37
III	14	32.3 – 38.0	35.71 ± 0.35	1.31	3.6	- 0.66
IV	12	33.0 – 38.5	35.80 ± 0.53	1.84	5.1	+ 0.09
V	6	34.0 – 37.0	35.81 ± 0.49	1.22	3.4	+ 0.01
VI	1	35.0	35.0 ± 0	0	–	- 0.81
			F E M A L E			
I	12	34.7 – 30.0	32.66 ± 0.48	1.68	5.14	–
II	32	35.0 – 29.0	32.03 ± 0.27	1.54	4.80	- 0.63
III	18	42.0 – 48.0	32.32 ± 0.65	2.80	8.66	+ 0.29
IV	8	33.8 – 29.5	31.46 ± 0.17	1.40	4.45	- 0.86
V	5	35.0 – 28.4	31.42 ± 1.19	2.67	8.5	- 0.04
Vi	11	33.0 – 28.0	30.4 ± 0.43	1.43	4.68	- 0.88

Table : 11 BILIOCRYSTAL BREADTH OF MALE & FEMALE

Age Group Number	Sample No.	Range	Mean-SE	S.D	C.V	Velocity
			M A L E			
I	6	25.8 – 24.1	25.0 ± 0.26	165	2.6	–
II	29	27.2 – 22.7	25.17 ± 0.19	1.04	4.13	+ 0.17
III	14	27.6 – 22.3	25.11 ± 0.36	1.37	5.45	- 0.06
IV	12	28.8 – 22.8	25.27 ± 0.51	1.78	7.04	+ 0.16
V	6	27.0 – 23.2	25.08 ± 0.52	1.28	5.31	- 1.19
VI	1	26.0 –	26.0	–	–	+ 1.92
			F E M A L E			
I	12	26.0 – 20.3	24.25 ± 0.42	1.47	6.06	–
II	32	27.0 – 20.4	24.59 ± 0.28	1.63	6.62	+ 0.34
III	18	28.0 – 22.5	24.97 ± 0.33	1.40	5.60	+ 0.38
IV	8	26.0 – 23.9	25.06 ± 0.24	0.70	2.80	+ 0.09
V	5	26.2 – 23.7	24.98 ± 1.37	0.83	3.32	- 0.08
Vi	11	27.0 – 22.0	25.11 ± 0.45	1.51	6.01	+ 0.13

Table : 12 T SCORE OF EIGHT ANTHROPOMETRIC TRAITS (N= 63 FOR MALE, N= 76 FOR FEMALE

	Measurment	t Value
1.	Stature	5.747 *
2.	Weight	7.179 *
3.	Height Acromion	5.706 *
4.	Height Iliocrystal	3.905 *
5.	Biacromion Breadth	4.464 *
6.	Biiliocrystal Breadth	0.425
7.	Transverse Chest	0.315
8.	Arm Circumference (left)	2.517 *

*Significant, $p < 0.01$, two tailed

Table : 13 CHILDREN EVER-BORN, INCLUDING STILL-BIRTH, SEX RATIO OF EVER-PREGNANT MOTHERS.

Mother's Age-group	No.	Total No. of pregnancies	Live Birth						Still Birth		
			Surviving			Dead					
			M	F	SR	M	F	SR	M	F	SR
15 - 49	52	175	67	72	0.93	18	13	1.38	3	2	1.50
50 - 70+	15	104	37	40	0.93	13	12	1.08	1	1	1.0
All ages	67	279	104	112	0.93	31	25	1.24	4	3	1.33

SR = Sex Ratio (m/f)

Table : 14 FERTILITY PATTERN PER MONTH OF EVER-GREGNANT WOMAN

Mother's Age-group	No.	Live Birth	Surviving	Dead	Still Birth	Pregnant
15 - 49	52	3.27	2.67	0.59	0.09	3.37
50 - 70+	15	6.8	5.13	1.67	0.13	6.93
All ages	67	4.06	3.22	0.84	0.10	4.16

SR = Sex Ratio (m/f)

Table : 15 MORTALITY BY AGE AND SEX

Age group (years)	Male	Female	Total	SR
0 - 4	5	7	12	0.71
5 - 9	20	13	33	1.54
10 - 14	3	4	7	0.75
15+	3	1	4	3.0
All ages	31	25	56	1.24

SR = Sex Ratio (m/f)

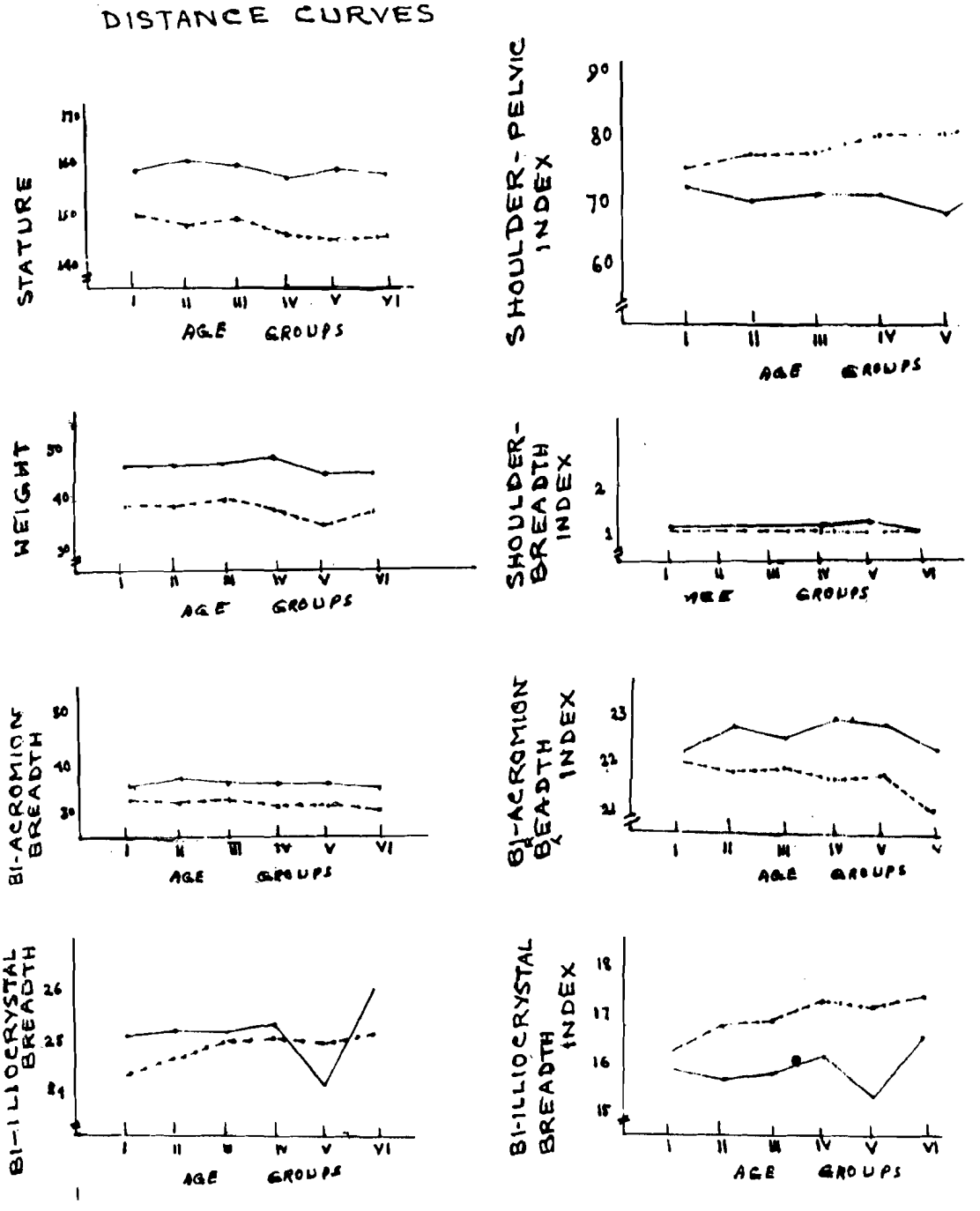
DISTANCE CURVES
STATURE
AGE GROUPS
SHOULDER-PELVIC INDEX
AGE GROUPS
WEIGHT
AGE GROUPS
SHOULDER-BREADTH INDEX
AGE GROUPS
BI-ACROMION BREADTH
AGE GROUPS
BI-ACROMION BREADTH INDEX
AGE GROUPS
BI-ILLIOCRYSTAL BREADTH
AGE GROUPS
BI-ILLIOCRYSTAL BREADTH INDEX
AGE GROUPS
MALE
FEMALE

FIGURE 1

VELOCITY CURVES

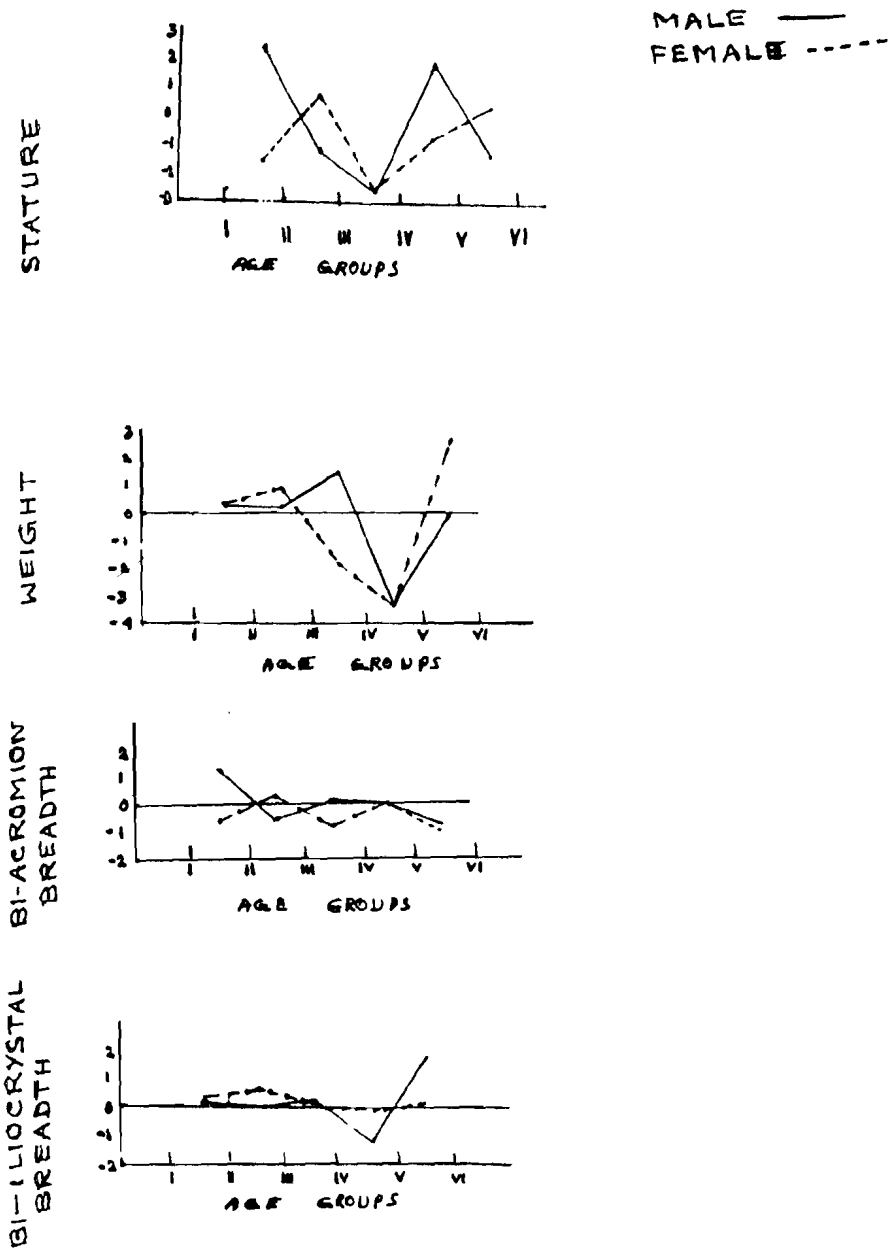

FIGURE 2