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Response of an Algal Community to Chromium

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Abstract

The paper deals with the study conducted for evaluation of the effects of chromium on the algal population by laboratory bioassay test. The results show that the algal species are affected differentially by the chromium concentrations ranging from 0.5 to 10 ppm.In general, the sensitive species to chromium include *Closterium acutum, Closterium cambricum, Closterium venus, Crusigenia fenestrata, Kirchneriella contorta, Monoraphidium capricornutum, Monoraphidium contortum ,Scenedesmus acuminatus, Tetraedron trigonum, Anabaena incrassata, Chroococcus turgidus, Merismopedia tenuissima, Spirulina laxissima, Cylindrotheca gracils* and *Melosir agranulata.* However, a few species like *Navicula viridula, Cosmarium depressum,* Kirchneriella *microscopica* and *Microcystis* aeruginosa were found to be tolerant to chromium, which could be exploited for their indicator value along with other species found tolerant by other workers.

Key Word: Algae, response, chromium, bioassay test

Introduction

Algae being autotrophic in nature have an important niche in aquatic systems. They are important link in the food chains and any change in their composition due to contamination of water can modify the biotic relationships thus changing the whole ecosystem. Many environmental contaminants like pesticides, heavy metals, variety of organic toxicants, organic matter and even nutrients can greatly influence the algal populations. The presences of pollutants have beçome a pervasive threat to many natural aquatic ecosystems. The pollutants can have toxic effects on almost all kinds of organisms and the biological process at the cellular, population, community and ecosystem level of organisations. The pollutants act on a number of cellular and biochemical processes critical to growth and production of algae. These processes include photosynthesis, nucleic acid production, protein and lipid biosynthesis, nitrogen fixation and uptake of nutrients.

Toxic effects on algae are difficult to generalize owing to interactions of toxicities with other physico-chemical factors, and the difference in the tolerance level of different algal species. Secondary effects of pollutants on algae may also exist due to stress on zooplankton community declining the grazing pressure. Due to this it becomes difficult to extrapolate the laboratory studies to natural field conditions (Trainor 1984)

It has been reported that the limits of safe concentrations of various pollutants to fish and aquatic biota may well be in the toxic range of several algal and zooplankton species. It becomes increasingly important, therefore, to understand the effects of pollutants on all kind of aquatic life to manage and keep the aquatic systems healthy, as well as to maintain the algal based waste water treatment and recycling systems (Patrick *et al.* 1968).

Though, a vast information has been generated on the effects of various pollutants on different aquatic life forms (Cairns *et al.* 1978, Gohash and Konar 1980, Welch 1980 and Goel *et al.* 1987) relatively little is known about the effeéts of heavy metals on algae (Statton and Corke 1979, Rai *et al.*1981, Goel and Shete 1977). The present paper deals with the effect of chromium on a natural algal community in laboratory conditions.

Experimental Set Up

The experiment was conducted in glass jars of 500 ml capacity having a wide mouth with surface area of 40.7cm^2. Chromium solutions of various strengths, i.e. 0.5, 1, 2, 5, and 10 ppm were made from potassium dichromate using algal water after killing and removing algae by boiling and filtration. The algal water was collected from two different ponds of which one was comparatively more polluted than the other Both the ponds were having a well developed algal community represented by a large number of genera. For running the experiment the algal waters

from these two ponds were mixed in 1:1 ratio. The mixed algal water was acclimatized to the laboratory condition for few days in a glass aquarium tank.

For experiment, the mixtures of variously diluted chromium solutions and the algal water were taken in the ratio of 3:1(300 ml of chromium solution plus 100 ml of algal water). In each set of various dilution, two replicates were taken thus employing total 12 jars with 400 ml of the above mixtures in each. The harvesting schedule of the experiment was kept as to collect 50 ml sample from each jar on first, third and sixth day from the start of the experiment. Some quantity of the original mixture was also kept to take the reading for the zero day. The collected samples were concentrated 10 – fold by centrifugation, and were preserved with 4%formalin for further study.

Results

The results of the experiment with regard to the change in the density of algal taxa in various concentrations of chromium are presented in Fig. 1, Table 1 and 2. The data indicated that a large number of species were declined in density, while a few showed a complete elimination during the six days of the experiment. However, a few concentrations of chromium were favorable to certain species that has reflected an increase of their density during the experimental period.

Effect of Chromium on Individual Algal Species

Chlorophyceae: The species *Closterium acutum* showed an adverse effect of chromium where it was decreased in the range of 50.0 – 76.56% in various concentration of the metal. However the decrease in density did not show a correlation with concentration of chromium. *Closterium venus* also showed an adverse effect with the decrease in density to the magnitude of 47.91 – 62.66% in various concentrations of chromium. On the other hand, the control showed a decrease of only 37.5%. *Closterium cambricum* was also the species that registered a quite significant decline up to 89.83% in 5 ppm of chromium. The control for this species, however, showed an increase in the density by 23.0%. *Cosmarium depressum* showed a mixed trend having a decline in density with 0.5 and 2 ppm chromium, and an increase in density with 5 and 10 ppm. Its density remained unchanged in 1 ppm. The increase in density was much higher than the magnitude of decline. Control also showed an increase in the density. The algal species *Crucigenia fenestrata* was found to get decreased in numbers in all the concentrations of chromium with maximum decline of 69.04% in 1and 2 ppm concentrations. The control for this showed a much lower decline of 28.57%. *Crucigeniella rectangular* is also showed a decline in all the dilution with the maximum decline of 89.43% in 2 ppm chromium concentration. *Kirchneriella contorta* registered a significant decline with total elimination in 10 ppm of chromium concentration. However, the control for this alga showed a marginal increase. Another species of this genus, *Kirchneriella microscopica,* on the other hand, showed a mixed trend with a slight decrease in density with 5 and 10 ppm chromium, but showing an increase in density in the lower concentrations. As the increase in the density was much higher in control with the value of 66.66%, it can be infer, therefore, that this species is adversely affected by chromium to a great extent.

The species *Monoraphidium capricornutum* also showed adverse effect of chromium having a decline in density in all the concentrations with highest fall of 56.21% in 0.5 ppm and lowest of 8.64% in 10ppm.The data indicate that the species is affected more in the lower concentrations of chromium. The second species of this genus, *M. contortum,* however, was much more affected than the former with the highest value of decline by 74.36% in 10ppm chromium. On the contrary, the control for this species showed a tremendous increase of more than 98.0%. There were three species of *Scenedesmus,* all of them getting adversely affected by chromium. *S. acuminatus* was completely eliminated in 2 ppm and registered a decrease of 66.66% in 1 ppm. The control for this showed a decline of only 27.77%. *S. arcuatus* was not much affected as compared to the previous one with the maximum fall in density to be 64.86% in 1 ppm followed by 37.84% in 2 ppm. This species showed, however a slight increase in 5 ppm as well in control. *S. quadricauda* has fallen in density to the tune of 84.04% in 2 ppm followed by 85% in 10 ppm. This species also showed a marginal increase in 1 ppm of chromium. The control for this species showed a greater decline of 69.15%.

Tetraedron trigonum showed a tremendous decline in density by chromium with even total elimination in 2and 5 ppm concentrations. The algal species *Tetrastrum triangulare* also suffered a decline in density with chromium

concentrations from 1 to 10 ppm. However, this species showed a very slight increase (1.04%) in 0.5 ppm concentration of chromium.

Cyanophyceae: Anabaena incrassata showed a decline from 69.90% to 88.67% in various dilutions of chromium. However, the control also showed a substantial decline of 70.55% in density. Still, the data indicate that the species is adversely affected by chromium. *Chroococcus limneticus* while showing a slight increase of 3.84% in 10 ppm,showed a substantial decline in the remaining dilution. The control for this, however, registered an almost 200% rise in density, thus indicating that the species is greatly suppressed by chromium. Another species of this genus *C. turgidus* also showed a substantial decrease in density with all the dilutions, whereas in control it was marginally higher.

Merismopedia tenuissima was also the species that got drastically affected by chromium with a highest decline of 99.25% in 10 ppm. The control for this species showed only 35.19% fall.

Microcystis aeruginosa, except for 1 ppm of chromium, showed an increase in all the dilutions with maximum value of 170.0% in 10ppm chromium concentration. As the control for this also showed a higher increase of 164.44%, it can be included that the species remains almost unaffected by chromium.

Oscillatoria limnetica showed a mixed trend with an increase in the density in 0.5 and 5 ppm chromium and a decrease in density in the remaining. The maximum decline was obtained (43.75%) in 1ppm while the maximum increase was 25% in 0.5 ppm chromium. The control for this showed a decline in density by 25%. *Spirulina laxissima* was drastically affected by chromium and showed complete elimination in all the dilutions.

Bacillariophyceae: *Cyclotella catenata* showed a decrease in density in 1, 2 and 5 ppm of chromium with the maximum value of decline by 51.24% in 2 ppm. In 0.5 and 10 ppm of chromium, however there was a marginal increase. The control for this also showed an increase but it was not high (15.30%). The overall results indicate that the species is only slightly affected. *Cylindrotheca gracills* suffered in all concentrations of chromium with a fall in density, which was maximum in 05 ppm concentrations of chromium with a magnitude of decrease by 77.41%. In control, on the other hand, this species showed an increase by 145.16%. *Melosira granulata* also declined in density in all the concentrations of chromium with total elimination in 2 ppm followed by 74.07% fall in 0.5 ppm. In control, the species showed a substantial increase of 166.66%.

Nitzschia closterium was found to be destroyed completely by all the concentrations of chromium as well as in control. *Navicula viridula* showed an increase in all the chromium dilutions together with control. The maximum increase was observed to be 806.25% in 0.5 ppm chromium. The increase in control was also of high magnitude (304.6%). The data indicate that the low concentration of chromium might be promoting the growth of this species.

Species adversely affected by chromium

The results of the experiments reveal that all most all the species except a few showed a distinct trend of getting adversely affected by different concentrations of the chromium. Table 3 gives the name of the species which were totally eliminated in either of dilutions or control. It was found that there were three species eliminated in each 5 and 10 ppm of chromium , 4 species in 2 ppm chromium and 2 species each in 0.5 and 1 ppm of chromium.

Some of the important species which showed an adverse effect of chromium were *Closterium acutum*, *Closterium venus*, *Coelastrum cambricum*, *Scenedesmus acuminatus*, *Tetraedron trigonum*, *Anabaena incrassata*, *Chroococcus turgidus*, *Merismopedia tenuissima*, *Spirulina laxissima*, *Cylindrotheca gracilis* and *Melosira granulata*.

The species *Nitzschia closterium* showed a total decline of the population in all the concentrations of chromium as well as the control, hence, it is difficult to make any inference whether the metal has any adverse effect on this species or there are some other enviromental conditions common to all the sets including control which are responsible for decline in density.

Table 1. Algae showing decrease (%) over the control on 6th day in different sets of various concentrations of chromium.

Name of the species	10 ppm	5 ppm	2 ppm	1ppm	0.5 pp	Control
Class: Chlorophyceae						
Closterium acutum	71.87	75.00	73.44	76.56	50.00	35.94
Cloterium venus	66.66	64.58	66.66	64.58	47.91	37.50
Coelastrum cambricum	86.44	89.83	85.59	86.44	70.34	-
Cosmarium depressum	-	-	37.50	00.00	31.25	-
Crucigenia fenestrata	38.09	61.90	69.04	69.04	40.47	28.57
Crucigeniella rectangularis	19.67	75.40	89.34	78.68	79.50	65.57
Kirchneriella contorta	100.00	76.47	87.50	80.88	72.05	-
Kirchneriella microscopica	25.12	6.37	-	-	-	-
Monoraphidium capricornutum	8.64	40.90	52.42	55.15	56.21	26.36
Monoraphidium contortum	74.36	67.94	62.82	69.23	46.15	-
Scenedesmus acuminatus	55.55	36.11	100.00	66.66	33.33	27.77
Scenedesmus arcuatus	12.16	-	37.84	64.86	3.97	-
Scenedesmus quadricauda	80.85	55.32	84.04	-	13.83	69.15
Tetraedron trigonum	68.00	100.00	100.00	66.00	62.00	11.50
Tetrastrum triangulare	78.12	48.96	88.54	75.00	-	61.46
Class: Cyanophyceae						
Anabaena incrassata	69.90	88.67	81.07	88.02	81.07	70.55
Chroococcus limneticus	-	40.38	15.38	46.15	0.64	-
Chroococcus turgidus	80.85	55.31	74.47	56.38	65.95	-
Merismopedia tenuissima	90.25	66.79	79.60	86.46	90.79	35.19
Microcystis aeruginosa	-	-	-	57.77	-	-
Oscillatoria limnetica	20.83	-	29.16	43.75	-	25.00
Spirulina laxissima	100.00	100.00	100.00	100.00	100.00	48.27
Class: Bacillariophyceae						
Cyclotella catenata	-	4.27	51.24	36.65	-	-
Cylindrotheca gracilis	58.06	64.51	61.29	69.35	77.41	-
Melosira granulata	48.15	62.96	100.00	66.66	74.07	-
Nitzschia closterium	100.00	100.00	100.00	100.00	100.00	100.00

Table 2: Algae showing increase (%) over the control on 6th day in different sets of various concentrations of chromium.

Name of the species	10 ppm	5 ppm	2 ppm	1ppm	0.5 pp	Control
Class: Chlorophyceae						
Coelastrum cambricum	-	-	-	-	-	23.73
Cosmarium depressum	85.41	133.33	-	0.0	-	135.42
Kirchneriella contorta	-	-	-	-	-	16.54
Kirchneriella microscopica	-	-	43.14	23.04	9.91	66.66
Monoraphidium contortum	-	-	-	-	-	98.72
Scenedesmus arcuatus	-	15.54	-	-	-	40.54
Scenedesmus quadricauda	-	-	-	18.08	-	-
Tetrastrum triangulare	-	-	-	-	1.0	-
Class: Cyanophyceae						
Chroococcus limneticus	3.84	-	-	-	-	195.51
Chroococcus turgidus	-	-	-	-	-	10.64
Microcystis aeruginosa	170.00	138.88	48.88	-	13.33	164.44
Oscillatoria limnetica	-	6.25	-	-	25.00	-
Class: Bacillariophyceae						
Cyclotella catenata	6.04	-	-	-	7.83	15.30
Cylindrotheca gracilis	-	-	-	-	-	145.16
Melosira granulata	-	-	-	-	-	166.66
Navicula viridula	216.66	229.16	16.66	91.66	806.25	304.16

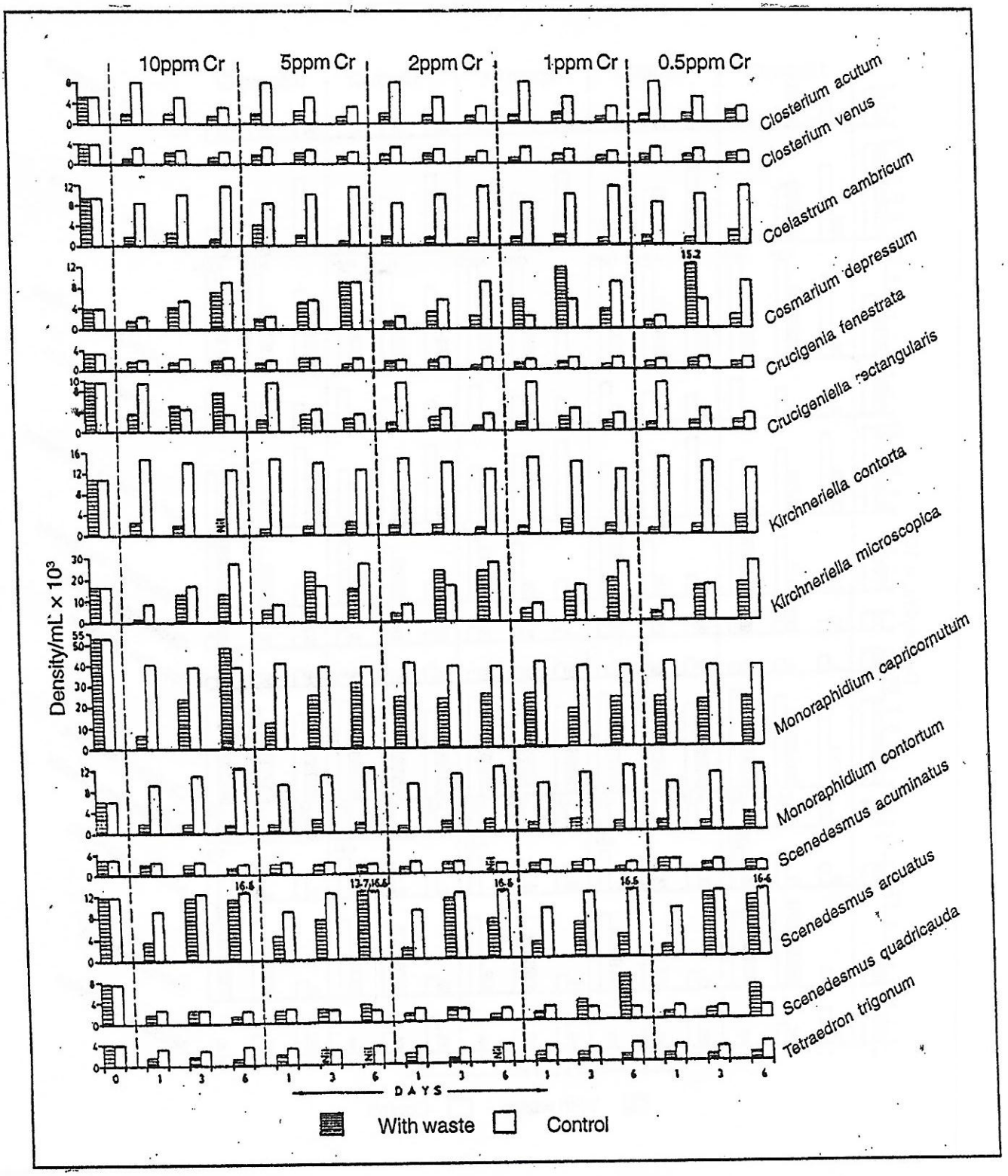

Fig.1 (A): Variation in Density of Phytoplankton Species in the Various Concentrations of Chromium

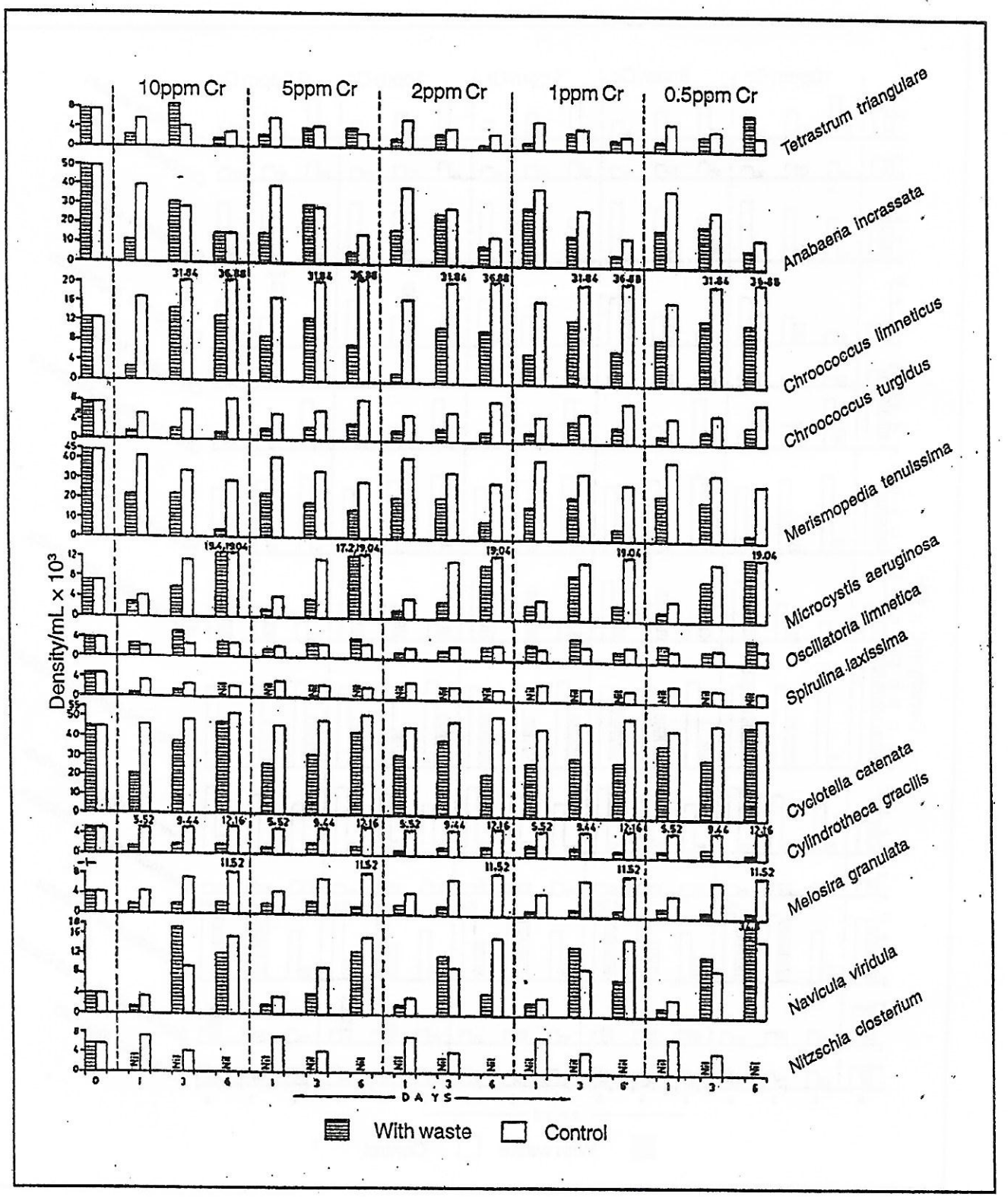

Fig.1 (B): Variation in Density of Phytoplankton Species in the Various Concentrations of Chromium

Table 3. Algal species showing different responses to chromium.

Species totally eliminated	Species adversely affected	Species promoted	Species with no clear trend
Kirchneriella contorta	*Closterium acutum*	*Navicula viridula*	*Oscillatoria limnetica*
Scenedesmus acuminatus	*Closterium venus*	*Cosmarium depressum*	
Tetraedron trigonum	*Coelastrum cambricum*	*Kirchneriella microscopica*	
Spirulina laxissima	*Crucigenia fenestrata*	*Microcystis aeruginosa*	
Nitzschia closterium	*Crucigeniella rectangularis*		
	Kirchneriella contorta		
	Monoraphidium capricornutum		
	Monoraphidium contortum		
	Scenedesmus acuminatus		
	Scenedesmus arcuatus		
	Scenedesmus quadricauda		
	Tetraedron trigonum		
	Tetrastrum triangulare		
	Anabaena incrassata		
	Chroococcus limneticus		
	Chroococcus turgidus		
	Merismopedia tenuissima		
	Oscillatoria limnetica		
	Spirulina laxissima		
	Cyclotella catenata		
	Cylindrotheca gracilis		
	Melosira granulata		

Species promoted by chromium

The species *Navicula viridula* showed a favourable response to the lower concentrations of Chromium while *Cosmarium depressum* was promoted at 5 and 10 ppm chromium and *Kirchneriella microscopica* was promoted at 0.5 and 2 ppm chromium. *Microcystis aeruginosa* also showed an increase in growth at 5 and 10 ppm of chromium.

DISCUSSION

Most heavy metals are toxic to algae with a varying degree depending upon the tolerance of the algal species (Kant 1989).While a few metals in small concentrations may be essential micronutrienuts to algae like copper, molybdenum and zinc etc., others such as cadmium, chromium, lead and mercury are toxic at almost all concentrations.The growth of algae in low concentration of essential metals remain normal but their increased concentration, as a rule, becomes toxic or lethal.

Whatever information on effects of heavy metals is available, comes from the laboratory studies, which according to Kant 1989 may not be fitted or extrapolated to natural habitats with large number of interacting factors. To overcome these limitations upto certain extent in the present study, the natural water enriched with chromium was used to grow the mixed population of algae rather than using single species cultures.

The studies so far conducted clearly indicate that the heavy metals pose a severe threat to the organisms in water including algae (Rai *et al.* 1981, Patric 1978, Whitton 1970, 1980, 1984, Welch 1980, Strokes 1983, Goel and Shete 1997). It is revealed from the studies that the algae exhibit different responses to different concentrations of heavy metals. The present experiment shows that while a large number of species (22) are sensitive to chromium, a few (four) show tolerance. Some of the extremely sensitive species to chromium include *Closterium acutum, C. venus, Kirchneriella contorta, Monoraphidium contortum, Scenedesmus acuminatus, Tetraedron trigonum, spirulina laxissima, Cyclotella catenata and Melosira granulata.*

The species showed tolerance to chromium include *Navicula viridula, Cosmarium depressum, Kirchneriella microscopica* and *Microcystis aeruginosa.* Palmer 1980 gave a list of 12 indicator algal species for chromium , i.e. *Closterium acerosum , Euglena acus , E. oxyceris, E. sociabilis, E. stellata, E. viridis, Navicula atomus, N. cuspidata, Nitzschia linearis, N. palea, Stigeoclonium lenue, and Tetraspora species.* It seems that the species of *Euglena* , in general , are quite tolerant to chromium.Our study adds some more species to the list of indicator species of chromium.

The reduction in the growth of *Scenedesmus*, by chromium in the present study is in confirmity to the observations made by Patrick 1978 who found that 5 ppm concentration of the metal is extremely toxic to this species. Many species of *Scenedesmus* have also been reported to be inhabited by other metals like cadmium (Goel and Shete 1997). According to Patrick 1978 many diatoms can flourish in lower concentrations of chromium, but can be replaced by blue greens at increased concetrations. It was also found in the present study that *Microcystis aeruginosa* increases substantially at 10 ppm of chromium, while *Navicula viridula* increases to several folds only at 0.5 ppm concentration.

The oxidation state of chromium is an important factor which may influence the toxicity as indicated by Patrick *et al.* 1968 who found that TLm (killing of 50% organisms) for diatoms was quite low (0.59 ppm) in case of Cr^{+6} as compared to the TLm value for Cr^{+3} revealing that the former is much more toxic than the latter.

Many studies showed that several species of algae bioaccumulate different heavy metals and, thus, may be used as indicators of metal pollution (Palmer 1980, Whitton 1984). While the impact of metals in isolation on a single species is worth studying, there is a need to study the toxicity of metals in relation to the presence of other influencing factors common to most natural situations. For example, a decrease in oxygen level in water can lead to the rise in toxicity of chromium (Cr^{+3}) to a great extent (Goel 1997). Considering the important status of algae, in aquatic systems, it is increasingly felt for an emphasis to understand the responses of algae to diverse pollutants specially in the natural habitats having complex interacting factors.

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Enviromental Problems of Using Water in India –Need for Generation of High Value Added Products

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Abstract

The present paper is an attempt to present the status of environmental problems using water with special reference to India. The paper is also highlighting the need to generate high value added products from the wastewater generated from various activities.

Key Words: Environment, water use, energy, value added products

Introduction

Water is a prime natural resource and is a basic human need. The underlying assumption in traditional water resources planning process still continues to be: "Fresh water is a gift of God which would continue to be available in a prepetuity and in abundance". This is not valid as both quantity and quality of water poses series problems.

Wastewater is a misplaced resource and can be reused to advantage through proper management. A differentiation, however, needs to be made between water reuse and recycling. Reuse implies utilization of water that has been previously used for another purpose, and recycle implies reuse of water more than once for the same purpose. India can take advantage of using bright sunshine, high temperatures and possibility of water usage for irrigating agriculture land for waste water management. The approaches in wastewater management should essentially entail: waste volume reduction, waste strength reduction; and by-product recovery.

It is estimated that out of the total precipitation of around 400×10^4 million cubic meter per year in India the surface water resources cover as 176.8×10^4 million cubic meter. Out of this only 50 percent can be put to beneficial use because of topographical and other constraints. Utilization of water resources in India is classified depending on nature of use into three main categories; domestic,agriculture,and industry. An estimated total water use in the country is 4074 millon meter cube per day for the year 2000-2001, the figures of distribution among various uses are 2.1%, 88 % and 2.4% respectively.

Water and Wastewater Status in India

Domestic Category

It is estimated that 31% of rural population and 77% of urban population in India has access to potable water supply. Surface water is the dominant source of organized urban water supply. In rural area ground water is the basic source. Municipalities and State Water Supply and Sewerage Boards own and operate the urban water supply schemes, however in rural areas there is no such organized water supply. Table1 gives the status of water supply, wastewater collection and treatment in Metropolitan cities of India.

The situation in sewerage collection treatment and disposal is discouraging as only 63% of the metropolitan population is provided with sewage collection and treatment system. The data obtained from remaining municipalities shows less than five percent of the total wastewater generated in Indian urban areas is collected and only about 2 % is receiving treatment leaving remaining 98 % discharged into the enviroment untreated.

This indiscriminate discharge of large quantity of untreated sewage into the surface water has deteriorate all the rivers in the country. India has 14 major rivers whose basin area is 83% of the total land area of the country, they contribute 85% of the surface water flow of the country and 80% of the total population is living in the basins of these rivers.

The preservation and restoration of river water quality in India started with the launch of much published Ganga Action Plan (GAP) in 1984. One of the important part of GAP was collection and treatment of domestic waste water discharged from urban centers located on the bank of Ganga. GAP phase-I has created an infrastructure for diverting 730 millions litre per day (MLD) and treating 540 millions litres per day of municipal sewage. The second phase of GAP aims in collection and treatment of domestic waste water from 95 towns. The Central Government has also initiated the National River Conservation Plan (NRCP) involving pollution abatement works in polluted streches of 18 rivers coverig 46 towns.

Often constuction of conventional sewage treatment plant requires huge capital cost. The Indian municipalities and public health departments are short of funds, thereby leaving most of the domestic waste water untreated. The viable option is to adopt cost effective/low cost sewage treatment scheme. Sewage farming is one such option, which utilizes partially treated sewage for irrigation to grow crops and vegetables.

Table 1. Status of water supply, wastewater collection and treatment in Metropolitan cities

Name of City	Water Supply Population Covered (%)	Sewerage System Population Covered (%)	Treatment Plant		Mode of Disposal
			Level	Capacity (MLD)	
Bombay	99	80	Primary	82.0	Creek, Sea
Delhi	96	75	Primary & Secondary	745.0	River Yamuna/ Agricultural land
Calcutta	95	-	Primary & Secondary	-	River Kulti & Hoogly
Hyderabad	100	75	Primary & Secondary	140	Land
Ahmedabad	90	75	Primary & Secondary	382	River Sabarmati
Banglore	100	85	Primary	286.0	Vrushabhavathi Valley, Bellandur Tank
Kanpur	75	60	Secondary	160	River Ganga, Agricultural land
Lucknow	100	-	-	-	-
Madras	85	77	Secondary	-	Sea, Irrigation
Nagpur	75	66	Primary (Not in operation)	45.5	Local Nallaha, Agriculture
Pune	78	53	Primary	90.0	River & Agricultural land
Jaipur	80	-	-	-	Agricultural land
Total	93	63		1930.4	

Source: Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities, CPCB, CUPS/ 30/ 1989 -190

Land Application of Sewage for Irrigation – A Case Study of Chandigarh

70 MLD of community waste water having 210 mg/ L of BOD, 423 mg/ L of TSS and 32 mg/ L of oil and grease were generated from urban area of Chandigarh. About 98% of the entire volume was collected at the sewage treatment plant (STP) and rest was extracted from the sewer trunk for land irrigation before it reaches the treament plant.This sewage was partially treated in STP to reduce the pollutants levels through 190 mg/ L of BOD, 405 mg/ L of TSS and 29 mg/ L of oil and grease. The partially treated wastewater is applied on land for cultivation of paddy crop. The sewage farm has 1250 acres of land adjacent to STP and is being utilised for past 10 – 15 years.

However, this sewage farm is not operated properly. There is heavy application of sewage water for cultivation of paddy crop, which has raised the water tabel of sewage farm upto the ground level. The quality of the grain and yield of paddy is not satisfactory. The accumulation of heavy metals in sewage irrigated soils was high compared to the soils reciveing tube well irrigation. The ground water near the sewage farm was showing high bacteriological contamination.

A study was conducted to improve the quality of the sewage farm. This study has recommended following important modifications and suggestions.

- Land preparation and drainage to avoid wastewater logging.
- Arrangement for periodic desludging.
- Provision for subsurface drains for water table control.
- Pretreatment of wastewater before application.
- Optimum loading of wastewater and scientific irrigation schedule for crop.

- Optimum fertilizer dosing.
- Soil management practices.
- Maintenance of soil pH level and organic matter.
- Crop rotation.

Industrial Category

Industrial growth in India took place after the liberalization of Indian economy in 1991. To focus on industrial pollution the Government of India has identified 19 critically polluted areas in the country and 17 industrial sub sectors which are polluting namely - cement, thermal power plant, distilleries, sugar, fertilizers, integrated iron and steel, oil refineries, pulp and paper, petrochemicals, pesticides, tanneries, basic drugs and pharmaceuticals, dye and dye intermediaries, caustic soda, zinc smelter, copper smelter and aluminium smelter. The list of critically polluted areas is given in Table 2. Out of a total of 1551 units identified under these cateogries by Central Pollution Control Board (CPCB), 1259 units have installed adequate facilities for pollution control, 112 units have been closed down and the remaining are installing the pollution control schemes.

Since November 1991, World Bank with MOEF is providing finance for pollution control projects to individual industrial units for pollution prevention and control. The funds are disbursed by Industrial Development Bank of India (IDBI) and the Industrial Credit and Investment Corporation of India Limited (ICICI). From this credit line of the world bank several units have taken loans amounting to more than 90 millions US dollar. In view of such positive response from industry, Government of India has recently negotiatedsecond line under Industrial Pollution Prevention Project where similar funds would again be available. In the case of new units, the cost of pollution control is internalized with the entire project cost and is fiananced within the overall fianancing package of the entire project . In general, this cost is less than 5% of the total capital cost of the project except for specific industry sub sectors where the cost may be as high as 10%.

Effective enforcement of enviroment legislation, increased public awareness and change in industry's perception of its social responsibility have resulted in significant increase in compliance to the various provisions of evironmental legislation in the large and medium scale industries .

Status of the wastewater treatment and reuse for selected industrial sector in the country is briefly given below.

Pulp and Paper Industry

In India there are more than 379 paper mills with an annual installed capacity of around 37.78 lakh tonnes. A Significant aspect of Indian paper industry is strong presence of small paper mills which contribute 50 percent to the production of paper and paper board in the country.

The water requirement to the paper mills in India is in the range of 250-440 m^3/ tonne of product and the requirement on the quality of paper made and extent of recycle. The water requirement is high compared to 60-120 m^3/ tonne water requirement achieved in several developed countries. Combined wastewater generation from large mills range between 167-281 m^3/ tonne of product. No significant variation in wastewater generation is observed. It is found that lignin bearing colored wastewater accounts about 30 percent of the total effluent discharged.

A study on waterwaste recycle in the paper industry has revealed that wastewater recycle varies between 8 and 48 percent with an average recycle of 21.4 percent, which facilitates reduction in fresh water requirement to the extent of 7 to 44 percent. A wastewater recycle pattern in a typical Indian paper mill is given Table 3.

The pulp and paper industry is adopting recycling of wastewater either without treatment or after suitable treatment. It is also observed that there is growing recycle awarenss in the industry.

Recovery of caustic soda from black liquor of small scale pulp and paper industries in common chemical recovery unit

An individual chemical recovery unit is not economically viable for small scale paper mill, hence a common chemical recovery unit for a number of paper mills is a recommended option where black liquor of individual mills can be collected and processed in a central recovery plant.

The common chemical recovery unit can be installed for a group of six to eight units located in the vicinity. Initially, a bench scale plant will be constructed to determine the design parameters. A bench scale study will essentially involve characterization of black liquors from different units to establish the suitability of their use as a feed for recovery and suggest methods to improve the liquor characteristics (to obtain higher solid content black liquor). The black liquor received from mills will be concentrated in multiple evaporation section. The semi concentrated black liquor then will be taken to recovery boiler and after increasing its concentration in cascade evaporator to convert into green liquor. This liquor will be reacted with lime and converted into white liquor for reusing as a cooking chemical in the paper mills.

Table 2. Critically polluted areas

Sl. No	State	Area
1.	Punjab	Mandi Gobindgarh
2.	Rajasthan	Pail
3.	Delhi	Najafgarh drain Vapi
4.	Gujrat	
5.	U.P.	Singhrauli
6.	Bihar	Dhanbad
7.	West Bengal	Durgapur
8.	West Bengal	Howrah
9.	Orissa	Talcher
10.	Tamil Nadu	North Arcot
11.	Tamil Nadu	Manali
12.	M. P.	Korba
13	Assam	Digboi
14.	Maharashtra	Chembur
15.	A.P.	Vishakapatnam
16.	Karnataka	Bhadravati
17.	Kerala	Greater cochin area
18.	Himachal Pradesh	Kala-Amb
19.	Himachal Pradesh	Parwanoo

Table 3. Wastewater recycle pattern in a typical paer mill

Type of Wastewater	Source	Recycle Process	Wastewater recycled (%)
Docker wash	Unbleached pulp filter	Screening and dilution of unbleached pulp at any place and chipping when required	56 - 60
Alkali backwater	Alkali extration stage filter	Diluting chlorination tower contents from 3% to 1% and alkali tower contents	90 – 95
Hypo backwater	Hypo extraction stage	Some system, alkali extraction stage and rage plant	80 – 90
Final washer backwater	Bleech plant	Some system and rag plant	80 – 85
Paper machine	Paper machine	Dilution high density pulp before feeding to paper machine and for hydrpulping	50 – 55

Source: Comprehensive Industry Document for Large Pulp and Paper Industry, Central Pollution Control Board, Delhi COINDS/ 36/ 1991

Tanneries

There are about 2000 tanneries in India. Approximately 75% of these tanneries are in the cottage and small scale sector, 20% in the medium sector and remaining 5% in the large sector. The total wastewater discharged from Indian tanneries is estimated to be about 50 million liters per day. The tanneries in India are cocentrated in clusters in the states of Tamilnadu, West Bengal, Uttar Pradesh, Karnataka, Punjab and Maharashtra. Tanning industry is water-consuming industry, approximately 30-40 liters of water is used for proccesing 1 kg of raw hide into finished lether. Most of the tanneries in India are located near the river banks or near the natural water bodies to draw surface water. Some tanneries also use ground water from the captive open wells. The quantity of water usage and nature of wastewater discharge in tanneries depend on type of tanning process, capacity of tannery and its production pattern.

The tanneries in India are grouped into three major categories from watewater management point of view.

1. Tanneries having adequate land and managerial capacity to built their own effluent treatment plant. There are about 100 large scale tanneries in the country. These tanneries have put up effluent treatment units.
2. Tanneries that are close to each other and are amenable to have a Common Effluent Treatment Plant (CETP). Common Effluent Treatment Plants are put up for these tanneries.
3. Scattered tanneries not having adequate land which can neither put up individual effluent treatment plant nor be included in a CETP. The only option for these tanneries is to shift to new location so that they can join the CETP scheme.

In India more than 80% tanneries adopt chrome tanning process, in this process 60% of the applied chromium is taken by the lether and remaining is discharge in wastewater. Research organizations like NEERI CLRI and IIT, Kanpur have developed technologies for reduction in chromium salt utilization for chrome tanning and for recovery of chromium from the waste water.

Recovery and reuse of chromium salt from tannery waste water

Lot of reseach work has been conducted in the past to evolve chemical methods of treatment to recover chromium from tannery wastewater. Some of the important methods are as under.

- Chrome recocery system based on dewatering of chromium sludge followed by incineration to produce ash which is leached with sulphuric acid to produce reuseable chrome liquor.

- In the second method the chrome liquor after filteration is treated with sodium carbonate to produce chromuim sludge which is dewatered in rotary vaccum filter. The filter cakes are dissolved in sulphuric acid to give chrome tanning solution.

- Another method of chromium recovery is the use of Magnesium Oxide (MgO) which has low reactivity and solubility causing chromium to settele in a very compacted way. The seperation from the liquor is obtained by decanting the supernatant. The sludge can be dissolved in sulphuric acid to obtain the reuesable liquor.

Most of the work carried on recovery of chromium is confined to laboratory only. Not much work has been done on full scale application. An in-depth study will be conducted on all the above technologies to estimate the process parameters for design of full scale plant. A cost benefit analysis will be carried to assess economic viability of the process. The study will also include the effect of recovered chromium on quality of leather produced and possibility of reuse the recovered chromium for number of cycles without affecting the quality.

Textile industries

Textile industries located at Small Scale Industrial (SSI) centers like Pali and Balotra in Rajasthan are known to be source of high wastewater pollution loads. A total of 767 units located in various areas of Pali are collectively contributing a large quantity of wastewater to the region.

NEERI has studied the pollution from these industries and prepared design packages for control of water pollution on a collective basis. Criteria as defined in table 4, and the basis for treatment presented in table 5, are utilized in preparing various options for such collective treatment. These options are presented in table 6. The capital costs, operation and maintenance costs are specific costs and specific costs were studied in detail to arrive at economically feasible option. One CETP at Pail has been commissioned successfully. NEERI has designed nine CETPs for different types of industrial clusters. The details are presented in Table 7.

Recycle and reuse of small scale textile and dying industry wastewater for industrial application

Textile processing comprises one or more the following processes desizing / kierning, bleaching, mercerizing, dying and printing. Additionally, carbonization is included for synthetic alkalinity, heavy metals, suspended solids colloidal material and colour followed by aerobic biological treatment to remove biodegradable organic matter.

Initally, bench scale treatability studies will be conducted to identify the suitable treatment unit to estimate the kinetic coefficients. Colour is an important parameter for dying industry. Dying industry wastewater will be subjected to ASP added with activated carbon. This treated effluent from modified ASP will be further treated / polished in sand filters. This treated wastewater can be reused in the process.

Enegy from Waste

Realizing the potential and importance of treatment of wastes and resultant recovery of energy from these wastes, the Government of India has launched in June, 1995 a National Program on Energy recovery from Urban, Municipal and Industrial wastes with a view to promote the adoption of proper technologies as a means of improving waste management practices in the country with the goals and objectives of (i) Creation of conducive conditions and environment with fiscal and financial incentives to help, promote, develop, demonstrate and disseminate and utilization of wastes for recovery of energy, (ii) improving the waste management practices through the adoption of technologies for conversion of wastes into energy and

(iii) promoting the setting–up of projects utilizing wastes from urban, municipal and industrial sectors.

Under this scheme 2.75 MW power generating plant using rice husk as feed material has been installed in Andhra Pradesh by M/s Gowthami Solvents Limited, Tanuku. 1 MW power generating plant based on biogas, generated from spent wash at K. M. Sugar Mills Distellery at Faizabad is under installation and biogas generating plants in over 50 distelleries in the country utilizing distellery spent wash have already been installed, a 4000 cubic meter per day biogas generating plant utilizing liquid wastes of slauter house at Hyderabad has been installed by M/s Al Kabir exports Limited.

Table 4. Criteria for the design of CETP's as developed by NEERI in consultation with MOEF

- Inventry of Industry
- Flow and characteristics of wastewater
- Classification of wastewater based on biodegrability (A, B, C and D as per Table 6)
- Design of conveyance system
  - Free from problems
  - Optimized scheme
- Treatibility study
  - Bench scale
  - Pilot scale
- Stengation of wastewater
- Pretreatment of wastewater
- Assessment and available technologies for design of CETP to develop treatment packages and optimization based on spatial distribution of CETP
- Ranking of technology options
- .Reuse/ recycling and resource recovery
- Disposal of treated effluents
- Cost estimation based on optimized CETP
- Cost bebefit analysis
- Scheme for sharing financial burden
  - Annualized capital cost
  - Operation and maintenance for different wastewater based on flow and mass
- Possibilities of using cleaner technologies
  - Process
  - Water consumption
  - Raw material
  - Energy requirement
  - Consideration of waste from one industry to be used as raw material for another industry

Table 5. Basis for wastewater categorisation

WWC	Pollutant	Treatment	Explanatory Notes	Pretreatment	Acceptability in CETP
A	High SS	Highly settable	Non toxic solids highly settleable	NP	Acceptable
A	High SS	Colloidal needs coagulant	Non-toxic solids settleable after coagulation	NP	Acceptable
A	Organics	Highly biodegradable	Organic solids in solution and/ or suspension, highly biodegradable	NP	Acceptable
A	Organics	Slowly biodegradable	Organic solids in solution/ or suspension, slowly biodegradable, example: benzene	NP	Acceptable
B	Inorganics	Acid	Mineral acids produced or used in excess	N & SEP	Acceptable on neutralisation
B	Inorganics	Alkali	Alkali produced or used in excess	CP & SEP	Acceptable on neutralisation
C	High TDS	Membrane separation	Highly soluble solids need membrane separation	NIP	Require expensive collective treatment using membrane separtation
D	Organics	Refractory	Naphthalene, anthracene used as raw material and/ or product	NIP	Require expensive collective treatment of ozonation and then to CETP
D	Organics	Toxic	Metal complex organo-chlorine pesticides carbonates	NIP	Require expensive collective treatment or incineration

NP: No pretreatment, NIP: No individual pretreatment, N and SEP: Neutralisation and solids separation, CP & SEP Chemical precipitaion and solid separation, WWC: Wastewater category

Table 6. Various treatment option for CETP

Option	Treatment Alternative
1	Primary Settling+Aerobic Biological Process (Extended Aeration)+Sand filter+Granular Activated Column+Disinfection
2.	Primary Settling+Anaerobic Biological Process (AFFB, DP 1 day)+Cascade Aeration+Sand filter+Granular Activated Column+Disinfection
3.	Primary Settling+Anaerobic Biological Process (AFFB, DP 0.25 day)+ Aerobic Biological Process (Extended Aeration) +Sand filter+Granular Activated Column+Disinfection
4	Physico-chemical process+ Aerobic Biological Process (Extended Aeration) +Sand filter+Granular Activated Column+Disinfection
5	Physico-chemical process+Sand filter+Granular Activated Column+Disinfection
6	Physico-chemical process+ Aerobic Biological Process (Extended Aeration) + Disinfection
7	Physico-chemical process+Anaerobic Biological Process (AFFB, DP 0.5 day)+Cascade Aeration+ Disinfection
8	Primary Settling+Aerobic Biological Process (Extended Aeration)+Disinfection

AFFB – Anaerobic Fixed Film Bed Reactor

Table 7. List of CETP's designed by NEERI for control of water pollution/ resource/ recovery/ recycle in cluster of small scale industries

Sr. No	State/ Town	Industries in Cluster		Flow	Annualised Cost (Rs. Lakhs)	Annual (Rs. Lakhs)	Salient Features
		Type	No.				
1.	Gujrat, Vapi	Chemical. Dying etc	750	16.0	271	114	Wastewater recycling for industrial area
2.	Himachal Pradesh, Parwanoo	Electroplating, Eng., etc	76	1.0	29	38	Conforming to standards
3.	Himachal Pradesh, Barotiwala	Chemical, Pulp & paper, etc.	34	8.4	313	413	Waste water recycling for industrial area
4.	Himachal Pradesh, Kala-Amb	Paper, textile, etc.	22	16.0	521	715	Wastewater recycling for industrial area
5.	Himachal Pradesh, Mehatapur	Textile, Eng., etc	111	0.37	15	27	Effluent conforming to standards
6.	Punjab, Amritsar	Textile	50	50.0	297	-	Effluent conforming to standards
7	Rajasthan, Balotra	Textile	367	7.7	635	191	Watewater recycling to industrial area
8.	Rajasthan, Pail	Textile	767	36.0	1900	1070	Wastewater recycling for industrial area
9	Tamil Nadu, Salem	Sago	641	12.0	291	108	Biogas recovery and aquaculture

Biogas generation from industrial wastewater

The proposed research work on anaerobic system will focus on process modifications. This work will involve estimation of factors like SRT , type of reactor , and loading rates to increase the process efficiencies towards optimal performance level. This work will also involve careful studies of factors like pH, temperature to maximise the growth rate of microorganisms involved in biological degradation of organic compounds. Determination of kinetic constants for different reactor types and industrial wastewaters. Scale up formulation for different types of reactor systems will be developed as scanty information is available on these aspects.

Intensive experimentation in above areas will increase the level of technology in the treatment of industrial wastes by anaerobic process to a much higher plateau than is realized today.

Agricultural Category

India is an agricultural country. Majority of the indian population live in rural areas and agriculture is their main occupation. According to an estimate 88% of the Indian water usage is consumed by agriculture sector. As per the livestock census of 1992 India has 204.5 million cattle 83.5 million buffaloes, 50.8 million sheeps, 115.3 million goats, 12.8 million pigs, and 307 million poultry birds. This is one of the largest livestock population in the world. The rate of the chemical fertilizer consumption has increased rapidly in our country as the emphasis is on increasing food grain production. The consumption of chemical fertilizer is given in Table 8. The compound growth rate in agricultutral production during 1950 to 1996 is 2.67 percent per annum as against the compound rate of nitrogeneous consumption, which is 11 %.

Contrary to the belief, agriclture sector is a major source of water pollution. The major factors of importance are reduction in wetland area, monoculture crop production, extensive use of commercial fertilizers and pesticides, irrigation and intensified husbandry. Irrigation, which consumes maximum quantity of water, is known to cause water quality problems such as i) salinization, ii) alkalinization, iii) erosion of irrigated land and iv) increase in sediments in downstream areas like lakes and dams.

There is a tendency in farmers to apply more fertilizers than the optimal in order to reduce a risk of being short of nutrients in good weathetr years. Excess chemical fertilizers and pesticides are washed off and reach the surface water or ground water. A survey has shown alarming increase in nitrates of ground waters of north India.

Livestock breeding and animal husbandry is another source of water pollution from agriculture sector. The major pollution source for animal husbandry are cattle slurry, (dirty water which contains washing from the farm yard and milking parlour), silage effluent (fermented grass used as cattle feed) and animal faeces and urine. Table 9 gives the BOD from animal husbandry sources. It is seen that BOD of animal sources is approximately 100 higher than raw domestic sewage. Considering the livestock population of India and BOD load, the estimated figures can be alarming.

There is a major and extensive built-up of water pollution from agriculture. However this is going largely unattended. Popular perceptions as well as regulatory institutions have focused upon urban and industrial pollution. There are no laws governing the pollution from agriculture sector vis-à-vis no extensive studies have been conducted in our country to estimate the water pollution from agriculture sector.

Table 8. Consumption of nitrogenous fertilizers in India

Sl. No	Year	Consumption Tonnes/ Year
1.	1951 – 1952	55000
2.	1961 – 1962	249800
3.	1971 – 1972	179800
4.	1981 – 1982	4068700
5.	1991 – 1992	8046300
6.	1996 – 1997	14930000
7.	2000 – 2001	22383000

Source:
(i) Comprehensive industry document Fertilizer Industry, CPCB, New Delhi COINDS/ 50/ 1994 – 95
(ii) India 1998, Ministry of Information and Broadcasting, New Delhi

Table 9. BOD of common animal husbandry wastes

Sl. No.	Effluent Type	BOD Range (ppm)
1.	Raw domestic sewage	300 – 400
2.	Cattle slurry	10000 – 20000
3.	Poultry slurry	30000 – 35000
4.	Sillage effluent	30000 – 80000

Causes for Present State of Affairs

Problems of Wastewater Management in Domestic Sector

Social Awareness

Indians in general are not aware of the environmental consequences of the discharge of the untreated wastewaters. Indian urban centres are administered by muncipalities or muncipal corporations which are governed by body of elected members. Potable water supply and collection and treatment of wastewater is not an inportant agenda of muncipal elections. Hence wastewater treatment is always a neglected issue and has least priority in policies of the municipalities.

Finance

Municipalities often depend upon the State/ Central Government for funds to construct the sewage treatment plants. These funds are either partially available or not available on time.

Bureaucracy

Administrative bureaucratic machinery in the municipalities and in State and Central Governments follow a lengthy and complicated procedure for decision making which cause excessive delay in policy formation and its implementation.

Lack of trained manpower

It is often observed that sewage treatment plants are not equiped with qualified and trained manpower to operate them efficiently. The staff is often inexperienced.

Problems of wastewater management in Industrial Sector

Technology

Although technology for conventional treatment for water and wastewater is available in the country, various studies in the past have indicated need for specific technologies for specific pollution parameter control. CPCB has assessed various wastewater treatment technologies with respect to know-how, equipment and there availability in India. The details of this study are reported in Table 10. Some of these technologies are already developed and demonstrated in the country while some needs development of design criteria and demonstration of applicability and efficiency.

Law Enforcement

The Central Pollution Control Board (CPCB) is the national apex body for assessment, monitoring and control of water pollution. The executive responsibilities for enfocement of the Acts for Prevention and Control of Pollution of Water (1974) and of the Water (Cess) act, 1977 are carried out through the board. Under the Environment (Protection) act, 1986, effluent and emission standards in respect of 61 categories of industries have been notified.

State Pollution Control Boards are formed to enforce the laws constituted by Central and State Governments at state level. However these pollution control boards are often deficient of funds, poorly manned and have inadiquate infrastructure for proper regulation of the pollution control laws.

Policy

An approach to industrial wastewater treatment should be to consider the problem in its totality and to include both preventive and curative aspects. This means that pollution control begins from the point of generation of wastewater and ends with ultimate disposal point. This concept could be broadly divided into two components, namely inplant control and end of the pipe treatment. In plant control consists of measures, which will reduce the wastewater quantitively and reduce the pollution potential qualitatively. This is achieved through appropriate selection of raw materials, cleaner technologies for production, conservation through recycle and reuse, by-product recovery and process and equipment modifications. This leads to preventive, internal, systematic, integerated, conservational and low pollution systems, which considerably reduce the load on end of the pipe treatment. End of the pipe treatment, theoritically, deals with treatment and disposal of wastewater, which are residual , after all the inplant measures are applied. In practice, however till recent past, inplant measures were not emphasized and consiquently the major pollution control efforts were concentrated on the end of the pipe treatment. But with the scenario of large scale industrial development, the focus of the policy planners and enforcing agecies should shift towards inplant pollution control thus permitting a holistic approach to pollution .

Problems of Environmental Management in Small Scale Industry (SSI)

Management/Economics

No investment returns on pollution control: The management of SSI's have taken the approach that pollution control is a dead-end investment. In many cases this fear is indeed realised, where the cost of installing pollution does not add to the productivity and to the botom-line profits of the enterprise. In addition the cost of operating the pollution control equipment cuts deeply into the normal cash-flow of the unit.

Investment for pollution control higher than initial investment of plant: The cost of pollution control has traditionally been compared with the initial investment required to set up the industry. As in the case with many highly polluting small units, e.g. glass, lime kiln, and dye-stuffs industry, the initial investment is of the order of 3 to 5 lakhs. Pollution control designed to reduce the pollutants to reasonable levels, would cost about the same amount. This causes the enterpreneurs not to install pollution control devices. However, the cost of

pollution control should be compared with the annual turn-over of the industry, because in some of these cases, the turn-over could be many times the initial investment. This fact creates the additional problem, that industry is more willing to enter protracted legal wrangling to buy time, rather than install pollution control equipments. When push comes to shove, they are willing to close down the industry and start over again.

Awareness: The awareness among the management of SSI's is fairly low with respect to technical options, finance availability in terms of subsidies and tax incentives for pollution control, and the legal repercussions of non-compliance with regulations. SSI is typically not aware of national level efforts in development and availability of non-or less- polluting technologies.

Operation of Existing Pollution Control Equipments: Due to the shortage of electricity and water in various states, having large number of small scale industries, e.g. Uttar Pradesh and West Bengal, operation of the pollution control devices is severely affected. And when electricity is available, the entrepreneurs choose not to operate the control devices to save on operating costs.

Economies of Scale

Due to the size of SSI sector, cost-effective and technically feasible pollution control becomes exceedingly difficult, if not impossible. Also due to the small size, the units often times operate in an inefficient manner. For example, the small lime kilns operate at low thermal efficiencies losing significant amounts of heat as waste heat. Also, the heat content of the flues are so small that heat recovery is not possible. In another example, hot flue gases at around 600 ^{0}C from cupolas pose severe problems for removal of particulates from the flue. The option of recovering the waste heat, as steam is infeasible because there is no demand for steam in the foundry or the immediately neighbouring industries.

Finance

Even though the Government provides soft loans for pollution control, with the interest rates in the neighbourhood of 12 – 14 % p.a., it hardly makes the investment in pollution control cost effective. SSI financial institutions and banks providing loans for setting up of SSI's are not aware of the environmental consequences of setting up the industry. As a result, the cost of pollution control has not been included in the feasibility studies, or required in business proposals from the entrepreneurs. If environmental costs are considered, they are done apart from the cost of the project, and not internalised as a part of the project.

Technology

Know-how for cost-effective control of pollution for the SSI sector is not readily available. A concerted effort in developing pollution control and less polluting production technologies do not exist, and efforts of R&D institutions are sporadic and they do not solve the problems effectively. Reputed consulting engineers have not shown interest in catering to the small scale, where as several unreliable consulting – shops have mushrbomed, providing inadequate and at times grossly wrong solutions.

Regulatory / Institutional

No effective regulatory mechanism exists for regulating, controlling and monitoring the pollution status of the SSI. Both the Central Pollution Control Board (CPCB) and the State Pollution Control Board (SPCB) are short of trained manpower and adequate funds to regulate large industries, let alone the small scale sector. Due to their very large numbers the efforts of the PCBs, if any, have been adhoc, and ineffective. Vast differences occur between the levels of effort of the PCBs in various states. This encourages location of SSIs in state providing lax control. This also causes unfair treatment with respect to the environment to the SSIs located in different states, affecting their competitive position.

No database regarding the pollution from the SSIs is available to assist in development of suitable environmental management policy, and regulations. Forthcoming efforts of CPCB and financial institutions towards environmental control have only started scratching the surface.

Problems of Wastewater Management in Agriculture Sector

The successive Governments formed at center and at state have always championed the cause of farmers by advocating the policy to increase agriculture production by increasing the chemical fertilizer dosing. These governments have encouraged this policy by providing subsidized chemical fertilizers, which has led to over application of fertilizers. Any attempt to discourage this by increasimg the fertilizer price will invite the wrath of powerful farmers lobby, which no government can afford due to its long-term political implications. Similar is the case with livestock breeding. Traditional Indian values encourage to have maximum number of cattle, as it increases ones social standing in rural India. Cows and bull are considered, as holy animals and religion prohibits their slaughtering. These reasons have caused rise in livestock population of the country.

Towards Pragmatic Solutions

To affect and change the burgeoning problem of wastewater treatment in India, pragmatic solution to these problems at the macro level (policy level) as well as at the grass roots levels in terms of the implementation needs to be made. One set of attempts without the other, would as in the past fail to produce the desired levels. Following are some of the possible solutions to tackle this problem.

- Adoption of low cost wastewater treatment systems for treatment of wastewater from small towns and cities. These technologies include water hyacinth pond, oxidation ponds, and application of wastewater for irrigation and constructed wetlands. These technologies require less capital and operation and maintenance cost but require large quantity of land which is available in plenty in the vicinity of smaller towns. Valuable by-products can also be recovered from these treatment schemes. For example, methane, fertilizer and water for irrigation from water hyacinth pond. It is reported that domestic wastewater ($3650x10^6$ m^3) can contribute $219x10^3$ tonne of nitrogen, $73x10^3$ tonne of phosphate, $146x10^3$ tonne of potash and $1460x10^3$ tonne organic matter with an economic value of Rs. 2000 million per annum.
- By imparting enviromental education to the urban population by making them aware about the problems and consequences of discharging untreated wastewater into the enviroment and their duties towards social hyginene.
- Providing financial support to the municipalities for wastewater management either from State/Central Goverments or from financial organisations at reasonable terms.
- Reducing the bureaucratic delays simplifying the process of decision making.
- Providing suitable training to the treatment plant operators for efficient running of the treatment plants.
- Common effluent treatment plants provide a viable option for a cluster of small industrial units which are not capable of setting up the treatment units individually on their own. Financial incentives in the form of grant should be made available for constructing CETPs.
- The need to encourage adoption of cleaner technologies (CT) for industrial production is requiered. Government of India is taking steps in this direction by setting up an Indian center for promotion of cleaner technologies (ICPC) with a large number of agencies operating as a network with access to databases within as well as outside the country. The ICPC, after becoming operational shortly, will be able to service the indutry for waste management purposes in the following ways :
  - recovering wastes.
  - treatment and disposal of wastes.
  - waste exchange to identify users for potential recyclable wastes.
- It is necessary to underline the fact that mere availability of technology is no gaurantee that waste management would be undertaken in a proper manner. Skilled manpower and management package is equally important input for sucessful completion of waste management programme. Considering the quantum of waste to be handled in the public sector, it is imperative that the constitutional mechanism is suitably strengthened and also made accountable for sucessfully and timely completing the assigned task. This aspect, however, has not received the requisite attention and needs to vigorously pursued along with the promotion of the resarch and development efforts in such areas as bio-technology intervention for waste management.
- Another approach would be to move from CETP to combined effluent treatment plant to jointly treat domestic sewage with indutrial wastes. Addition of domestic sewage from surrounding community will not only solve the problem of community waste treatment but will also improve the treatability of industrial waste water.

- There are at present several fiscal incentives for installations of pollution control equipment and for shifting indutries from congested areas. However, economic instruments should be ammended to encourage the shift from curative to preventive measures, internalise the cost of pollution and conserve resources, particularly water. One possible suggestion is effluent should be charged based on the nature and volume of releases to the envoirment. The charge will be based on the cost of treatment and the flow discharged, thus putting thrust on optimul release of wastewater. The precise choice of economic instruments adopted should be determined by the ease with which releases can be measured, as well as prospective changes in technology and market structure.
- At present the disincentives include penalties and fines for non compliance under the various acts as well as the water cess. All of these incentives are extremely low in relation to the cost of pollution prevention/control for compliance. This can be overcome by increasing the amounts of penalties and fines.
- In addition to the above, some market instruments could also be employed. One such instruments is the "Eco-mark" labeling system. This system, through public awareness, could provide market forces to encourage envoirment friendly production processes.
- Another marketing instrument could be rating of industries, similar to financial rating (CRISIL) or ISO-9000. A good tool would be BS-7750 the british standard for envoirmental management system or ISO-14000.
- Problems associated with SSI could be solved by helping genuine SSI's especially those promoted by young and technically qualified enterpreneurs. Although adequate network of institutional finance exists, yet there is a need for co-ordinating the flow of both short and long term capital. Government should co-ordinate making capital available to SSI's, on right time and at appropriate terms. Fianancial institutions created for assisting SSI's should require enviormental impact studies on appropriate scale prior to project fianancing. Enviormental experties should be made available with the fiańancial institutions for this purpose.
- By providing R & D encouragement; create instruments for R&D related to cleaner technologies of production and pollution control from SSI.
- Multi-media compliance represents a more holistic approroach for achieving a clean enviorment. This approach examines the big picture - emmissions, the geographic locations, wind patterns, social impact - in order to come up with a plan that will be both effective and practically reliable. Release to all enviormental media (eg. Air emisssions, wastewater discharges, and hazardous wastes) are considered simultaneously and in an integrated manner. This means that the environment permit or licence for a facility address all envoirment media, as do compliance inspections and enforcement responses.

The advantages are :

- o It allows the consideration of cross media effects, e.g. The effect of wastewater treatment on solid waste and air polllution generation.
- o It allows the facility operation to consider a full range of envoirmental improvents.

Forward thinking decesion makers in several countries have incorporated this new focus into legislation and policy with positive results.

- By promoting and implimenting low cost wastewater treatment schemes for management and treatment of wastewater from agriculture and rural areas. One such example is wetland transformation. The capacity of wetlands to remove nutrients and organic loads from freshwaters has been emphasized. Natural riparian wetlands are believed to play a key role in the removal of nutrients, especially nitrates. Several studies have shown the efficiency of constructed wetlands in groundwater storage and recharge has also been proven in many areas, yet it is often neglected in water management planning.
- Restoration or creation of buffer strips or resparian ecotone along the water courses can arrest nutrient flow in rivers. Such areas are known to have high nitrogen removal capacity by denitrification and uptake by macrophytes followed by harvesting and storage in the sediments. Wetlands, possibly in the form of wet buffer strips along the water courses, have the same potentials.
- By implementing the schemes to popularise the use of organic nutrients in agriculture through the use of compost green manures and bio-fertilisers.
- By making a national policy of reducing the consumption of chemical fertilisers and pesticides.
- Controlling the livestock population and improving the quality of breed.
- By increasing the awareness on envoirmental sanitation in rural areas by providing education.

Conclusion

Water and wastewater management problems in india is different from developed countries as it is linked with gross inadequacy of envoirmental sanitation, lack of politacal will, shortage of fund and, non availability of technology and social, religious and cultural values. While taking the stock of the situation, one is left to ponder about how little has been done so far in this regard and how big is the magnitude of the problem ahead.

Table 10. Assessment of wastewater technology status in India

Sr. No.	Process	Control Parameter	Industries where required	Present Status in India	Assessment of Import Needs			Notes
					Technology	Hardware		
						Total	Critical Component	
1.0	Adsorption	BOD, COD, Toxic Compounds, Colour, Odour	Dyes and Intermediates, Textile, Paper, Pharmaceuticals, Pesticides, Fruits, Canning, Petrochemicals, Rubber Chemicals, Man-made Fibres	Limited product range	Yes	No	-	Import of know how for technology of activated carbon manufacture and regeneration. Import of technology for synthetic adsorbents. Initial import of special adsorbents including activated carbon.
2.0	Biotechnology							-
2.1	Conventional	BOD, COD	For all industreies – biodegradable and slowly biodegradable					
2.1.1	Aerobic							
A.	General			Developed	No	No	No	
B.	Rotating Biological Contractors (RBC)			Under-developed	Yes	No	Yes	Import of process know how and in hardware initial import of Disc Segments only.
C.	Diffused Aeration			Limited range	Yes	No	Yes	Import of know how for manufacturing of diffusers and initial import of porous diffusers of various materials
2.1.2	Anaerobic			Developed	Yes	No	No	Import of know how for the design of reactors including anaerobic activated sludge, egg shaped digesters etc.
2.2	Advanced	BOD, COD						
A.	Microbial Cultures/ Enzymes			Research stage	Yes	No	Yes	Initial import of know how and cultures/ enzymes especially for recovery of single products.
B.	Bioreactor			Under developed	Yes	No	Yes	Import of know how for design of aerobic and anaerobic reactors such as deep shaft, towe, loop, upflow and downflow fixed film and fludized bed etc. Also initial import of critical components, if necessary
3.0	Disinfection							
3.1	Conventional (Chlorination etc.)	Pathogens		Developed	No	No	No	
3.2	Ultraviolet	Pathogens		Nil	Yes	No	Yes	Import of know how and critical components
4.0	Dissolved Air Floatation	Suspended Solids/ Oil and Grease	Metal processing and finishing, Petroleum refining and petro-chemicals, Dairy, Edible Oil, Textile processing, Dyestuff, Tanneries, Food and Fruit processing	Limited product range	Yes	No	Yes	Import of know how and critical components
5.0	Electro-Dialysis and Electro-Deposition	Heavy Metals	Metial processing and finishing, Caustic Soda	Nil	Yes	No	Yes	Import of know how and critical components especially membranes
6.0	Evaporation and Crystallization	Toxic Organic and Inorganic Salts	Pulp and Paper, Distillery, Metal Processing and Finishing, Textiles, Organic Chemicals and Petro-chemicals	Under developed	Yes	No	Yes	Import of know how for vaccum evaporators and critical components

Table 10. Continues.....

Sr. No.	Process	Control Parameter	Industries where required	Present Status in India	Assessment of Import Needs			Notes
					Technology	Hardware		
						Total	Critical Component	
7.0	Incineration	BOD, COD, Toxic Organics	Paper, Distillery, Tannery, Pharmaceuticals, Pesticides, Petro-chemicals, Petroleum, Dyestuff Intermediates	Under developed	Yes	No	No	Import of know how especially for effective combustion system
8.0	Ion Exchange	Heavy Metals, NH_3, Cyanides, Fluorides	Caustic Soda, Fertilizer, Manmade Fibres, Rayon, Pulp & Paper, Distillery, Pharmaceuticals, Metal processing & finishing, Electronics, Ferrous and Non Ferrous	Limited product range	Yes	No	No	Import of know how for the manufacture of macroraticular resins and selective ion exchange resins. Initial import of macroraticular resins and selective ion exchange resins.
9.0	Ozonation	BOD, Colour, Odour, Refrectory Organics, Toxic Chemicals, Pathogens	Iron & Steel, Dyes and Intermediates, Pharmaceuticals, Petro-chemicals, Paper, Pesticides	Nil	Yes	No	Yes	Import of know how and initial imports of ozonation
10.0	Reverse Osmosis	Dissolved Organics	All Industries for reclamation of water	No	Yes	No	Yes	Import of know how and membranes. Import of know how for suitable pump manufacture and critical components
11.0	Sedimentation	Suspended Solids, Oil and Grease						
11.1	Conventional			Developed	No	No	No	-
11.2				Under developed	Yes	No	No	Import of know how
12.0	Sludge Handling Treatment and Disposal							
12.1	Handling		All Industries	Limited product range	Yes	No	No	Import of know how for the manufacture of srew pumps for high consistency sludges and air lift pumps.
12.2	Treatment							
12.2.1	Thickening			Developed	No	No	NO	-
12.2.2	Dewatering			Under developed	Yes	No	Yes	Import of know how for manufacture of centrifuge, belt filters etc. Also import of critical components.
12.2.3	Digestion	Organic Sludge		Under developed	Yes			Import of know how for reactor design
12.2.4	Composting	Organic Sludge		Developed	No	No	No	
12.2.5	Thermal Dewatering	Organic & Inorganic Sludge		Under developed	Yes	No	No	Import of know how
12.3	Ultimate Disposal							
12.3.1	Smelting	Toxic Inorganic Sludges		Developed	No	No	No	
12.3.2	Incineration	Organic Sludges		Under developed	Yes	No	No	Import of know how
12.3.3	Stabilization and Solidification	Toxic and Hazardous Sludges		Nil	Yes	No	No	Import of know how
13.0	Ultrafiltration	COD, Dissolved Polymers and Colloidals	Dairy, Oil Refinery, Wool Industry, Breweries, Paper, Paints	Under developed	Yes	No	Yes	Import of know how and critical components especially membranes.
14.0	Control and Monitoring	Various Parameters	All Industriess	Limited range product	Yes	No	Yes	Import of know how for instruments for continuous monitoring and sampling systems, specific ion electrodes, flow measurements and recording. Also import of critical components and initial import of instruments.

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Sources and Quality of Drinking Water in Relation to its Impact on Health with Reference to Tribal Groups of Chotanagpur Plateau.

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Abstract

Sources and quality of drinking water were studies in the tribal belts of Chotanagpur plateau of Bihar. The main sources of drinking water are: supply water, wells handpumps, streams, ponds, rivers and pitwater. Physico-chemical parameter are within the permissible limits. But, the bacterial contamination was recorded in all the water sources. Due to the use of such contaminated water, the population suffers from diseases like diarrhoea, jaundice, amoebic dysentry, typhoid etc. It is advisable that such water must be treated before use.

Key Words: Chotanagpur plateau, tribal, drinking water, sources and quality ,water borne diseases.

Introduction

Water is the prerequsite of life. A regular supply of neat and clean water is essential for different metabolic activities. The general scarcity of safe potable water has become a global problem. Supply of potable water has been affected by contamination of water sources in most developing countries. Rivers, lakes and ground water have been polluted by industrial effluents, run-off, and urban waste. Ground water is the major source of drinking water in many parts of India. Due to direct or indirect interferences of human beings, the water has been found to contain various pollutants that cause harmful effects on drinking water and adverse impact on human health and aquatic life as well (Telliard and Rubin 1987). The increase in human population and fast development has led to the scarcity of drinking water. Much of the ill health in the underdeveloped countries is largely due to lack of safe drinking water. In India, only 12%of people get good clean water (Kudesia 1986). Chotanagpur platue belt of Bihar is highly industrialised area. The area is mainly dominated by tribes. The objective of present study is to analyse the sources and quality of drinking water in relation to its impact on health.

Materials and Methods

Water reasources were seen with the personal visit of the sites as well as interview with villagers. Water sampels from different areas were collected and analysed for different parameters according to APHA 1975 and Trivedy and Goel 1984. Ten water sampels were colleced from each study area. Sterilized tubes were used for collection of water samples for bacterial count.

Sources of Drinking Water

During our field survey we found following sources of drinking water in this zone.

a) **Supply water:** This mode of drinking water is confined to industrial and bureaucratic areas like Jamshedpur, Rakha, Jadugoda, Ghatshila, Dhalbhumgarh, Musabani, Chakylia, Bharagora,etc. Water is of high quality. In Jamshedpur, supply water comes from two sources, one from Dimna lake and another from Swarnarekha river.

b) **Wells:** The most common source of drinking water is well. This may be either Kuccha or Pukka. Pukka wells are made by government or by other agencies. Generally, Kuccha wells dry in summer. Kuccha are unhygenic in conditions. Kai, Lichens, Mosses, generally grows on the mouth of wells and during the water use, used water diffuses into it. Tribals are since not aware of hygiene, this causes severe gastrointestinal problem. In Chakuria itself there are 78124 wells out of which only 464 are used for drinking purposes.

c) **Ponds :** This area since gets 150-200 cm rainfall annualy. This becomes a good source of drinking water in remote villages. During the visit, we observed a number of ponds filled with water. Some of the ponds are

perennial while other dries in summer. Water of these ponds is used to prepare food at home by nearby residents. Number of ponds are greater in Potka block.

d) **Hand pump :** In most of the area Government has provided hand pumps as a source of drinking water. But during our survey work we found that most of the hand pumps were not working in lack of proper maintenance. The tribal people are so poor that they are even unable to provide valve and washer for the functioning of the hand pump. As the water level in this region is very low, most of the pumps become dry during summer season.

e) **Streams:** East Singhbhum is fortunate to have many small streams. These streams are the major (better to say only one) source of drinking water in remote tribal villages. Water of Bakai and Jog streams caters the need of the villagers of Kulamara, Rowam and Kumirmuri region.

f) **Pit water :** The situation becomes worst during summer season when most of the small rivers and Hand pump as well as wells dry up. Villagers have to travel miles to fetch drinking water. During our visit, we noticed that in many areas villagers dig river beds to a depth of 5' to 6' for water. Many villagers reported that water of such pit in the bed of river becomes so dirty that it is not possible to drink it. They filtered the water with the help of cloth and then use it. We noticed that such stagnant water becomes a very suitable breeding ground of mosquito.

g) **Artesian Well :** These are very rare sources. We have seen (rare sources) only one artesian well in Kulamara village. Water from this well flows and after tresspassing paddy fields joins with Bakai stream. We have noticed that people were using water for daily purpose.

Results and Discussion

The pH of water samples varies between 7.10 and 7.69 which is well within the safe limits. Turbidity is also within permissible limits. Total hardness below 300 mg/ L is considered potable. In the present study hardness is within the permissible limits. Total alkalinity and TDS are also within the permission. The sulphate content of natural water is an important considration in determining their suitability for public water supplies. Higher concentration of sodium sulphate in water can cause misfunctioning of alimentary canal. The cloride values varies between 3-60 mg/L which is within the permissible limits (40-160mg/ L). There has been a considrable research work related to nitrate contamination of ground water due to point, non-point and natural sources. Increasing nitrate contamination in ground water is associated with a diseas known as Methamoglobinema (infant cynosis), if it is present in concentration above 44 mg/ L (WHO,1984). The nitrate value in the present investigation is within the permissible limits (28-35mg/ L).

High iron concentration has been associated with gastrointestinal disturbances (Babcock 1951and Sharmah 1994). Beside this, high iron concentration is also associated with hepatic and pancreatic troubles as well as abortion and mental disorders. High concentration of iron in drinking water has been reported by many workers in various parts of India (Aowal 1981, Kakati *et al.* 1990, Das *et al.*1992, Pandey *et al.* 1992, 1994 and 1998). Endemic flurosi continues to be a challenging problem. It is one of the common oral healthproblem of humanity in developing countries. Water with high content of fluorides is the main cause of fluorosis. According to Rao 1998 about 225 million indian scattered in different status are affected with fluorosis. In the present study the fluoride value ranged between 0.6-0.65 mg/ L which is within the permissible limits.

In the present study the MPN values are found to vary from 5-62 MPN /100ml. The highest MPN value was found in Kulamara. It is an established fact that the very high mortality rate is found among the population using pond/ reservoirs/ streams/ rivers and earthen wells as the main source of drinking water (Ghosh 1985, ICMR 1985). Further, water contamination is an integral factor, which cognizably increased with urbanization and industrialization by direct and indirect means. This poses a threat to water sources which have evolved into a formidable factor in the spread of human and animal diseases. The causitive agents for typhoid, fever, bacillary dysentery, amoebic dysentry, paratyphoid fever and cholera spread by water (Charles and Alice 1957). The prevalence of water borne diseases in these tribal population is not surprising because major sources of drinking water in these tribal villages are river, lakes, ponds, pits and wells.

The coliform values in the present study are found to exceed the standard permissible limits and, therefore, indicates a high degree of pollution at these points. The water of these villages are potentially hazardous to the

health of the public. During the course of present study we have noticed that the tribal population residing in these areas are victims of a large number of diseases such as Diarrhoea, Jaundice, Amoebic dysentery, Cholera etc. The percentage of these diseases in the local tribal population have been shown in the Table 2.

Coliform MPN /100 ml of sample, in most of the areas is very high which indicates the poor quality of water in turn indicating possible fears of sewage mixing with water. On the whole, it can be concluded from the present study that tribals are prone to several diseases due to consumption of such polluted water. If the adequate use of alum and other disinfectants is made and villagers are made fully aware about hygenic use of potable water, then only water borne diseases can be controlled. The Government must also take care of ecologically undeveloped tribals of Chota Nagpur plateau to improve the quality of drinking water.

Table 1. Average physico – chemical and bacteriological quality of tribal villages of Chotanagpur Plateau.

Sl. No	Parameters / Spots	Colour	Turbidity	pH	Total Hardness	Total Alkalinity	Fluoride	Chloride	Nitrate	Sulphate	Total Dissolved Solids	Iron	MPN/ 100 ml
	E. SINGHBHUM												
1	Deosol	Clear	7.0	7.69	145	140	0.80	148	34	35	275.0	Trace	32
2	Borodih	Clear	22	7.38	150	158	0.60	048	28	40	375.0	0.20	25
3	Kulamara	Clear	20	7.58	170	172	0.70	160	38	60	550.0	0.20	62
4	Borakata	Clear	8.0	7.50	155	160	0.60	145	35	50	525.0	Trace	45
	GUMLA												
5	Chainpur	Clear	6.0	7.10	100	140	0.80	040	-	05	180.6	0.25	5.0
6	Kurumgarh	Clear	5.0	7.35	80	80	0.70	060	-	05	185.5	0.12	10
7	Tigawal	Clear	8.0	7.45	70	70	0.65	040	-	05	163.4	1.00	12
8	Tetardipa	Clear	7.0	7.25	120	120	0.70	120	-	03	240.6	0.25	18
9	Jate	Clear	5.0	7.20	60	60	0.60	050	-	20	0.120	0.12	09

All the values are in mg/L except pH

Table 2. Distribution of water borne diseases among Tribal populations of Chotanagpur Plateau

Sl. No	Diseases / Tribal Population	Population (no.)	Diarrhoea	Jaundice	Amoebic Dysentry	Typhoid
	E. SINGHBHUM (Jamshedpur)					
1	Santal	844	22.86 %	16.94 %	37.44 %	22.74%
2	Oraon	134	22.38 %	14.92 %	26.11 %	36.56 %
3	Bhumij	257	23.34 %	19.45 %	37.35 %	19.84 %
4	HO	302	19.20 %	17.21 %	43.04 %	20.52 %
5	Kharia	117	25.64 %	17.09 %	34.18 %	23.07 %
6	Munda	87	28.73 %	17.04 %	32.18 %	21.83 %
	GUMLA & RANCHI					
7	Oraon	371	11.90 %	7.01 %	15.90 %	3.50 %
8	Munda	238	19.33 %	7.14 %	21.43 %	5.46 %
9	Korwa	103	21.36 %	9.71 %	28.16 %	7.77 %
10	Kharia	47	27.66 %	8.51 %	34.04 %	6.38 %

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Seasonal Fluctuations in the Plankton of Suswa River at Raiwala (Dehradun)

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Abstract

The present paper is an attempt to present the findings of investigation on the river Suswa. It is evident from the present study that the water quality of Suswa River has deteriorated during the recent past due to increased human influx.

Key Words: Suswa, river, water quality, Himalaya

Introduction

In India, fourteen major rivers systems share about 83 % of the drainage basin i.e. Indian rivers carry about 16,45,000 million cubic metres of water annually Rao 1975. The Himalayan rivers receive 20 –30 % of their water from meltd snow and ice during summer and monsoon seasons. The Suswa river is a spring fed tributary of the River Ganga. The water quality of Suswa river has deteriorated considerably due to increased human interferences in several ways viz. bathing, dumping of domestic wastes, sewage discharge, etc. These anthropogenic activities have not only affected the river water quality and its biota adversely, but have also incresed the unusability of water for social and economical purposes. Hence, the present study was conducted to investigate the riverine ecological factors of the river Suswa at Raiwala in district Dehradun, the foot hills of Siwalik Himalayas.

Materials and Methods

The water samples were collected fortnightly from different sampling stations in morning hours (07.00 to 10.00AM). The analysis of different physico – chemical and biological parameters was done by following the methods by Welch 1948, Trivedi and Goel 1984 and APHA 1995.

Results and Discussion

The ecological conditions of a river or stream have a direct bearing upon the different producer to consumer level in aquatic life and physico – chemical parameters impart a major role in determination of the quality of any water body. The average values of physical and chemical parameters are tabulated in Table 1 and 2. The seasonal quantitative analysis of the planktonic number and percentage of different groups among photoplankton has shown in Table 3 and 4.

In the Suswa river at Raiwala, a difference in the fluctuation of water temperature was maximum (26.25^0 C $\pm$ 1.68) observed in summer and minimum in winter. The maximum velocity (1.16m / sec$\pm$ 0.169) was recorded in summer. The velocity starts continuous decreasing from summer to winter. The velocity and the residue shared positive relationship. Badola and Singh, 1981 reported similar trends in the river Alaknanda. High pH (8.36 $\pm$ 0.40) in winter may be due to higher algal population in the river. The pH and dissolved oxygen showed a positive relationship. The maximum value of free CO_2 was recoded (3.59 ppm $\pm$ 0.22) in summers. The dissolved oxygen was found maximum (9.10 ppm$\pm$ 0.25) in winter due to the photosynthetic and respiratory activities of the biota as also observed by Hynes 1970, Dobriyal and Singh 1981 and Khanna 1993. The maximum value of alkalinity (326.86 ppm$\pm$ 14.76) was observed in winter due to decomposition of the organic matter. Similar type of findings were observed by Venkatesvarlu and Jayanti 1968 in the river Sabarmati.

The maximum value of hardness (100.83 ppm ± 2.65) was recorded in summer and showed a positive relationship with chloride as also observed by Chopra and Patric 1994 in the river Ganga at Rishikesh. The amount of calcium in the river Suswa was found to be maximum (85.14 ppm± 1.76) during winter. The river may be regarded as rich in calcium contents (80.39 ppm ± 1.59 to 85.15 ppm ± 1.76). Similar type of relationship was observed by At Kin and Harris 1924 in fresh water bodies. BOD and COD showed a positive relationship with one another. Similar type of relationship was reported by Chopra and Patric 1994 in the river Ganga at Rishikesh. BOD and COD have showed a negative relationship with dissolved oxygen as also observed by Verma *et.al.* 1984 in eastern Kalinadi.

The plankton are the heterogenous assemblage of minute organisms present in the natural waters. The total planktonic concentration was recorded maximum 91236.59 units/L± 196.38) in winter, due to the blanketing effect caused by velocity. Allen (1920) has shown that the water current above the moderate speed is directly inhibitory to plankton development. Maximum percentage of different groups were noted as Bacillariophyceae (Diatoms 81.83 %) in winter Chlorophyceae (Green algae) 19.49 % in summer, and Cynophyceae (Blue green algae) 4.55% in summer. Among the total plankton, Bacillariophyceae dominated over Chlorophyceae, Cyanophyceae and Zooplankton. Same trend of domination was reported by Khanna 1993 and Joshi *et.al* 1996 in the river Ganga at Haridwar.

Table 1. Seasonal variations in physical parameters ofSuswa River

Seasons / Parameters	Summer	Monsoon	Winter	Average
Temperature (°C)	26.25 ± 1.68	23.52 ± 0.24	21.80 ± 1.45	23.86 ± 0.045
Velocity (m/Sec)	1.16 ± 0.169	0.95 ± 0.021	0.65 ± 0.19	0.92 ± 0.036
Total Solids, TS (ppm)	219.30 ± 29.74	170.04 ± 5.09	142.39 ± 24.64	177.24 ± 4.18
Total Dissolved Solids, TDS (ppm)	211.53 ± 27.43	166.59 ± 4.34	140.06 ± 23.01	172.73 ± 4.14
Total Suspended Solids, TSS (ppm)	7.77 ± 2.31	3.45 ± 0.75	2.33 ± 1.54	4.51 ± 0.053

Table 2. Seasonal variations in chemical parameters ofSuswa River

Seasons / Parameters	Summer	Monsoon	Winter	Average
pH	7.47 ± 0.23	7.53 ± 0.18	8.36 ± 0.40	7.79 ± 0.008
Free CO_2 (ppm)	3.59 ± 0.22	3.36 ± 0.63	2.86 ± 0.29	3.27 ± 0.013
Dissolved Oxygen (ppm)	8.31 ± 0.31	8.84 ± 0.06	9.10 ± 0.25	8.75 ± 0.022
Mineral Acidity (ppm)	61.12 ± 3.24	55.89 ± 0.46	52.61 ± 2.77	56.54 ± 0.56
Total Acidity (ppm)	3.76 ± 0.06	3.71 ± 0.028	3.53 ± 0.098	3.67 ± 0.025
Alkalinity (ppm)	288.90 ± 12.08	302.17 ± 2.69	326.86 ± 14.76	305.98 ± 0.91
Chloride (ppm)	21.99 ± 2.75	16.84 ± 0.89	15.48 ± 1.85	18.10 ± 0.13
Hardness (ppm)	100.83 ± 2.65	97.45 ± 0.26	92.95 ± 2.92	97.08 ± 0.39
Calcium (ppm)	85.14 ± 1.76	82.40 ± 0.18	80.39 ± 1.59	82.65 ± 0.36
Magnesium (ppm)	15.69 ± 0.89	15.05 ± 0.43	12.56 ± 1.32	14.43 ± 0.036
BOD (ppm)	2.05 ± 0.21	1.77 ± 014	1.42 ± 0.23	1.75 ± 0.037
COD (ppm)	4.49 ± 0.11	4.36 ± 0.014	4.18 ± 0.11	4.34 ± 0.013

Table 3. Seasonal quantitative analysis of the plankton of the RiverSuswa

Parameters / Seasons	Number of plankton per litre of water		Total plankton per litre of water
	Phytoplankton	Zooplankton	
Summer	629.92 ± 150.39	94.25 ± 15.56	724.17 ± 165.95
Monsoon	804.00 ± 27.30	111.83 ± 3.13	915.83 ± 30.43
Winter	1093.92 ± 177.70	142.67 ± 18.68	1236.59 ± 196.38
Average	842.61 ± 191.38	116.25 ± 20.01	958.86 ± 211.40

Table 4. Number and percentage of different groups among the phytoplankton of the river Suswa during different seasons

Parameters / Seasons	Total plankton/ L	Total diatom/ L	Total green algae/ L	Total blue green algae/ L	Percentage of different groups		
					Diatoms	Green algae	Blue green algae
Summer	629.92 ± 150.39	477.52 ± 135.74	123.78 ± 12.11	28.62 ± 2.55	75.96	19.49	4.55
Monsoon	804.00 ± 27.30	638.61 ± 21.84	136.05 ± 3.43	29.34 ± 2.04	79.12	17.14	3.74
Winter	1093.92 ± 177.70	892.35 ± 157.59	162.88 ± 15.54	38.69 ± 4.58	81.83	14.61	3.56
Average	842.61 ± 191.38	669.49 ± 170.76	140.90 ± 16.32	23.22 ± 4.30	78.97	17.08	3.95

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Growth Inhibitory Activity of 6-Methoxyageratochromene on *Culex-Quinquefasciatus* (Diptera : Culicidae)

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Abstract

During present study it was recorded that 6-methoxy ageratochromene isolated from whole herb acetone extract of *Ageratum conyzoides* inhibits the growth and moulting in the second and fourth instar larval treatment of *Culex quinquefasciatus*. When the plant extract were applied topically, the average pupal period prolonged significantly ($p < 0.05$) as compared to those of the control. Fourth stage larvae just prior to metamorphosis were most sensitive. Mortality in larvae, pupae and during ecdysis brings about a considerable fall in population. This growth index was found to be reduced in *Ageratum conyzoides* ($P < 0.01$) compared to the control.

Kew Words: Growth disrupting, ecdysis, morphogenetic, aberration, precocene

Introduction

Ageratum conyzoides (family –Asteraceae) is an herb distributed throughout India and subtropical countries. Bowers 1976 have isolated an antipalatal compound 7-methoxy-2, 2-dimethoxy chromene that caused precocious metamorphosis in Insects. Anti – juvenile hormone activity in the crude petroleum ether extract of *Ageratum conyzoides* against *Culex quinquefasciatus* (Saxena *et al.* 1992) have prompted us to isolate the active principle present in the crude extract which caused growth inhibitory effect on filarial vector. Earlier studies (King 1954, Jacoson 1982, Sukumar *et al.* 1991, Zarroug *et al.* 1990, Saxena *et al.* 1992 and Tunon *et al.* 1994) have shown that extracts from several plants have mosquito repelling, insecticide and growth regulatory characteristics.

The present paper reports the effect of a purified compound 6-methoxyageratochromene on the growth and metamorphosis of filarial vector *Culex quinquefasciatus* (Diptera Culicidae).

Materials and Methods

Plant Material: The whole herb was collected in and around Vidisha. The identification of plant was done at P. G. Department of Botany and the identified voucher specimen was preserved in the herbarium of the laboratory. Air-dried powdered material was extracted in Soxhlet apparatus using acetone as solvent. Crude acetone extract was evaporated to dryness under vacuum evaporation below 40°C.

Structure Elucidation of Active Principle: The crude extract was partitioned with n- hexane, $CHCl_3$ and EtOAC. The concentrate EoAC soluble part was chromatographed over silica gel glass column. Elution with $CHCl_3$: MEOH (9:1) yielded a compound, which was crystallized, from Et_2O. Acetylation on reflux condenser with acetic anhydrite yielded a compound of mp 154 M /578 which was determined as 6-methoxy agerantochromene by comparing with the spectral data of authentic compound. The IR (KBR) Elmer Model showed characteristic absorption at 2950 cm^{-1}, for the methoxy single sharp peak at 1590 cm^{-1} for amine and 1350^{-1} cm for (C H) with single sharp peak at 800 cm^{-1} for mono substitute benzene ring adjustment at para position. The H- NMR spectrum of the compound displayed singlet at 1.4 (6H) assignable to 2-CH_2 group, a singlet as 3.77 (3 H) due to a methoxy group. Another proton centered at 5.097 and 6.12 attributed to the benzene ring and a multiplet at 1.42 and 1.45 (3H) due to a methoxy group. Another proton centered at 5.097 and 6.12 attributable to the benzene ring and a multiplet at 1.42 and 1.45 (3H) due to aromatic proton. H-NMR pattern due to aromatic proton further revealed that the methoxy group has to be either C_50C_6 in position which when compared with the spectrum of authentic sample reveled the structure of the extracted compound.

Experimental Bioassays: The bioassays was conducted in the insectary maintained at 70 to 85 % RH 14: 10.1 D and 27±1 °C as per Standard Method of WHO 1971 using laboratory culture stream of *Culex qunquefasciatus* (Diptera Culicidae).

The analysis of variance was calculated following the methods by Finney 1971. The detailed bioassay procedure was adopted as reported earlier by Saxena *et al.* 1992.

Results and Discussion

The results of the study have indicated that the larval period was significantly reduced in all the five concentrations as compared to the control. Higher concentration caused acute toxic effect on the larvae. The larvae, which survived, were smaller in size. Few of them could attain adulthood and adult normally get drowned in water since they were unable expand their wings. Many of the growth inhibited larvae died during ecdysis. Some of the larvae that molted successfully died occurring to failureof melanization.

The results showed the mortality and developmental defects. The LC_{50} and LC_{90} value for 2nd and 4th instar larvae recorded 51.16 and 35.02 ppm and 56.23 and 127.9 ppm respectively. This showed that 4th instar larvae before pupueation are more susceptible than 2nd instar larvae to ageratochromene. Growth index was significantly found reduced at 50 ppm concentration ($P < 0.001$). Similar growth regulating activities of *H. tuberculatum* extract was reported by Mohsen *et. al.* 1989 against *Culex qunquefasciatus*.

In our earlier work (Saxena and Saxena 1992) the crude petroleum ether extract of *Ageratum conyzoides* was found to induce growth of larvae of *Anopheles stephensi* along with the toxicity to the larvae. The compound that caused developmental defects and demalanization of larval cuticle was isolated as 6- methoxy ageratochromene. Thus in addition to our earlier work the present results showed development defects in the larvae of filarial vector as potent chitin inhibitor causing demalanization of skin.

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Fish Fauna and Fish Production of Tribal District West Nimar (Khargone) of M. P., India

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Abstract

A sùrvey of fish fauna was conducted between July 1998 and December 1999. The fishes were collected from the local market of block head quarters of the tribal district West Nimar (Khargone). In all 40 species belonging to 23 genera and 10 families have been found in this area. They are Cirrhinus, Catla, Chela, Labeo, Oxygaster, Puntius, Garra, Barbus, Rasbora and Tor belonging to Cyprinidae family; Lepidocephalichthys, Nemacheilus belonging to Cobitidae family; Ompok and Wallago belonging to Siluridae family; Mystus and Rita belonging to Bagridae family; Notopterus, Heteropneustus, Clarias, Xenetodon, Channa and Matacembelus belonging to Notopteridae, Heteropneustidae, Clarridae, Belonidae, Ophiocephalidae and Matacembelidae family respectively. It is also observed that non culturable fishes are most widely distributed and the commercial culturable fihses are commonly found in the region. In the present paper, the fish fauna of the district West Nimar is discussed.

Kew Words: Fish fauna, west Nimar, fish production

Introduction

The complete account of the fish fauna of Madhaya Pradesh is not available. Day 1889 has published fish fauna of British India including Ceylon and Burma. Since then there have been several publications on the fish fauna of various parts of India. Noteworthy publications are of Hamilton 1922, Misra 1952, Menon 1954 and Srivastava 1968. As far as Madhaya Pradesh is concerned several studies have been done in the past. The fish fauna of Mahanadi was published by Hora 1940. Swarup 1953 and Qureshi and Qureshi 1970 studied the fishes of Sagar lake. Soni 1959 gave an account of fishes of lower lake of Bhopal. Dubey and Mehra 1959 described the fishes at Jabalpur. Misra, 1962 gave an account of fishes available in the M. P. The present communication is an attempt to report the fish faua of tribal district of westNimar.

The tribal District West Nimar is situated in the west southern part of Madhya Pradesh, between the latitudes 21° 25' and 22° 35' North and longitude 74° 25' and 76° 140' East. The total area of this district is 13285 sq. km. and it is on the 7th position in the state. The elevation varies from 500 feet to 1365 feet above MSL. The avérage annual rain fall is 830 mm. The lowest temperature is 12°C in winter and maximum temperature is 46 °C in summer season. The total catchment area of river Narmada is 121 km in this region. The total water area is 4199.583 ha. Map of District West Nimar is shown in Fig. 1.

Materials and Methods

The fishes were collected with the help of nets from all possible habitats and from market of different block headquarters such as Khargone, Seagone, Zimiya, Niwali, Bhagwanpura, Barwah Pansmal, Pati, Barwani, Rajpur, Thikri, Gogawa, Kasrawad, Bhikangoan, and Maheswar between July 1998 and December 1999 after first monsoon showers. The 10 % formalin solution was injected in the the body. The samples were identified with the help of standard literature available. The specimen were deposited in the museum of Zoology Department of Post Graduate college, Khargone.

Results and Discussion

In all, 40 species of fish fauna belongings to 23 genera and 10 families were identified from this region these are shown in Table 1.

Table 1. The fish fauna of the Tribal District West Nimar

Family		Species
1.	Notopteridae	1. *Notopterus notopterus* (Pallas)
2.	Cyprinidae	2. *Cirrhinus mrigala* (Ham.) 3. *Cirrhinus reba* (Ham.) 4. *Barilus bola* (Ham.) 5. *Catla catla* (Ham.) 6. *Chela laubuea* (Ham.) 7. *Chela atpar* (Ham.) 8. *Barilus barna*(Ham.) 9. *Labeo rohita* (Ham.) 10. *Labeo calbasu* (Ham.) 11. *Labeo bata* (Ham.) 12. *Labeo boga* (Bloch) 13. *Labeo genius* (Ham.) 14. *Oxygaster bacaila* (Ham.) 15. *Puntius ticto* (Ham.) 16. *Puntius Sarana* (Ham.) 17. *Puntius sophore* (Ham.) 18. *Rasbora doniconius* (Ham.) 19. *Tor tor* (Ham.) 20. *Tor putitera* (Ham.) 21. *Gara gotyala* (Ham.) 22. *Barbus pinnauratus* (Ham.) 23. *Barbus tor* (Ham.)
3.	Cobitidae	24. *Lepidocephlichthys guntea* (Ham.) 25. *Nemacheilus beavani* (Day) 26. *Nemacheilus aurius* (Day)
4.	Siluridae	27. *Ompak bimaculatus* (Bloch.) 28. *Wallgo attu* (Bouch & Sohn.)
5.	Bagridae	29. *Mystus seenghala* (Sykes.) 30. *Mystus aor* (Ham.) 31. *Mystus bleekri* (Day.) 32. *Rita rita* (Ham.)
6.	Hetropneustidae or Saccobranchidae	33. *Heteropneustus fossils* (Bloch.)
7.	Claridae	34. *Clarias batrachus* (Linnaeus)
8.	Belonidae	35. *Xenentodon cancila* (Ham.)
9.	Ophiocephlidae	36. *Channa punctatus* (Ble.) 37. *Channa gachua* (Ham.) 38. *Channa marulius* (Ham.)
10.	Matacemelidae	39. *Matacembelus pancalus* (Ham.) 40. *Matacembelus armatus* (Lacepede)

Dubey and Mehra 1959 in the survey of Chambal river, reported 71 different species of fishes. Soni 1959 described 35 different type of fishes in lower lake of Bhopal. Dubey and Verma 1965 gave an account of 104 species of fishes of Madhya Pradesh. Badola 1975 reported the fish fauna of Garhwal Himalaya, Khanna and Badola 1990 reported the ichthyofauna of the river Ganga from at the foot hills of Garhwal Himalaya. In the present survey, however, 40 species belonging to Notopteridae, Claridae, Belonidae, Cobitidae, Silridae, Bagridae, Heteropneustidae, Claridae, Belonidae, Opheocephalidae and Matacembelidae families were identified from this region (Table 1). It was also observed that the non culturable fishes are most widely distributed and the commercial culturable fishes are common in this region.

The yearwise total fish production in the district is shown in Table 2 and Fig. 2. It was lowest in 1993-94 while in the year 1998-99 it was highest. The reason behind the lowest production in the year 1993-94 was low rainfall on one hand and non availability of good seeds on the other hand. The maximum production defeating all the previous records resulted due to the implementation of Rajiv Gandhi Mission and the availability of the good seeds, which was missing in the previous years. Need not to say the Rajiv Gandhi Mission motivated the people

to come forward and to be benefited by the programmes for the upliftment of them laid down by the Government.

Fig. 1: Map of district West Nimar (Khargone), M.P.

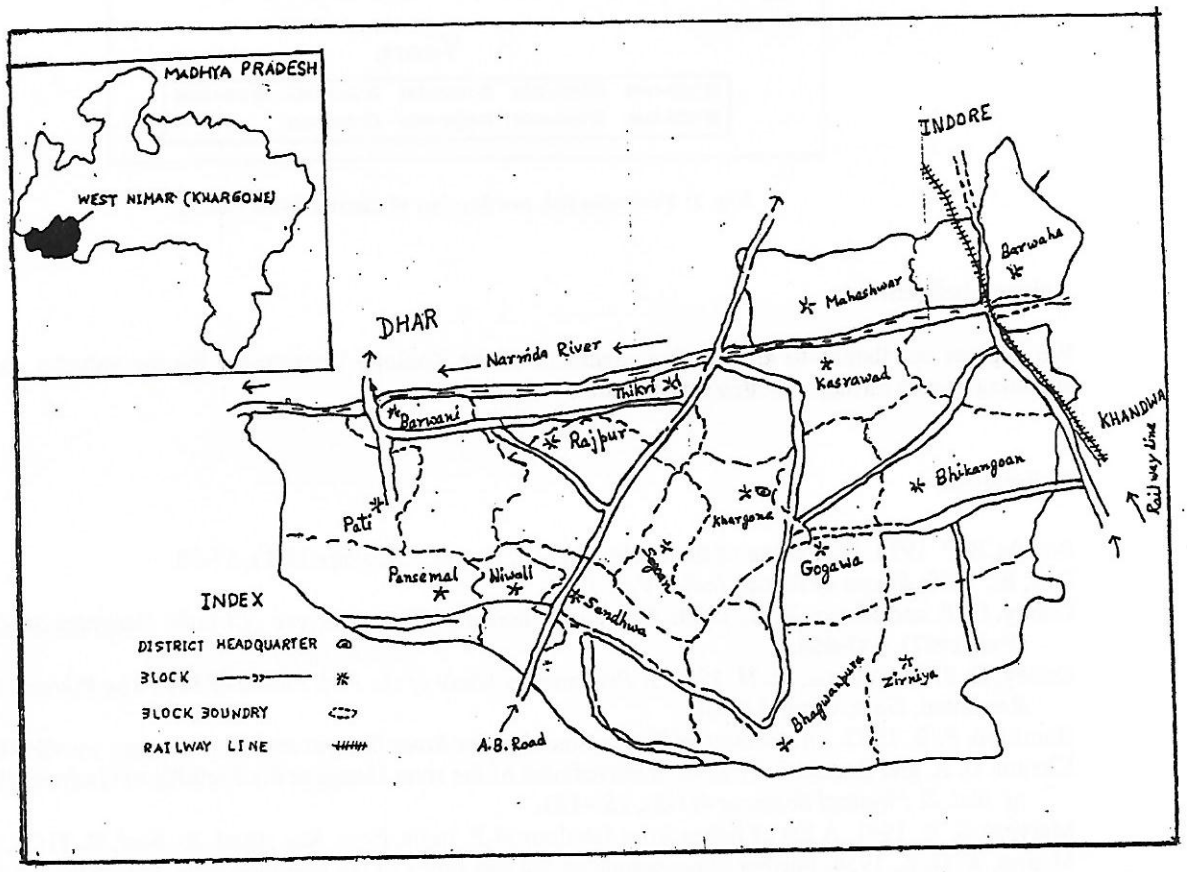

Table 2. The year wise fish production in Tribal District West Nimar

Sl. No	Years	Fish production (MT)
1.	1990-91	419
2.	1991-92	367
3.	1992-93	485
4.	1993-94	279
5.	1994-95	300
6.	1995-96	1396
7.	1996-97	1625
8.	1997-98	1660
9.	1998-99	1728

Sources: Annual report of District Fisheries Office.

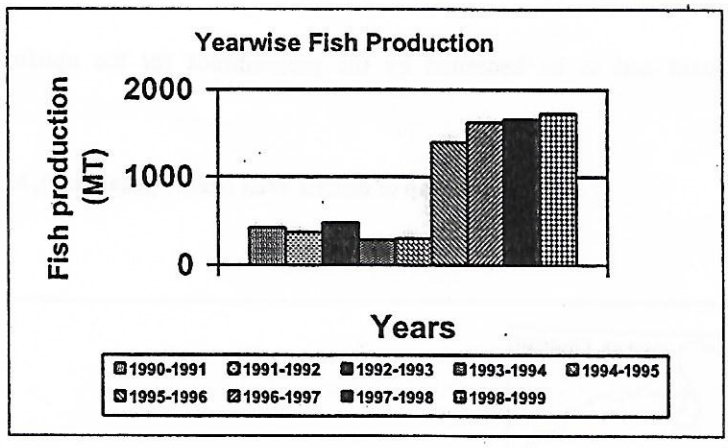

Fig. 2: Yearwise fish production of district West Nimar

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Water Quality of Rampur Reservoir of Guna District (Madhya Pradesh, India)

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Abstract

Rampur reservoir is one of the artificial water bodies of Guna (M.P.). The villagers use it mainly for irrigation as well as for pisciculture. Physico-chemical studies were undertaken to enhance the Limnological knowledge about the tank and to explore possibilities for better management of pisciculture. In the present study various physico-chemical factors such as water temperature, transparency, turbidity, conductivity, pH, alkalinity, dissolved oxygen and chloride were investigated. The recorded parameters showed interrelationship and also indicated the suitability of reservoir for the purpose of drinking and pisciculture. Proper awareness of pisciculture to the villagers is required for the proper utilization and exploitation of Rampur reservoir.

Key words: Rampur reservoir, water quality, pisciculture

Introduction

The Rampur reservoir is one of the artificial water bodies of Guna, situated at a distance of just 34 miles from Guna town. The work on the tank was started in 1908 and was completed in 1917.Rampur is the nearest village. Direction of the reservoir is north west of Guna, it lies between 24° 47' N and 77° 10' E. The reservoir has a catchment area of approximately 102 sq miles and it is a part of Chambal Jamuna Basin. The reservoir serves as a source of irrigation for the villagers. Fishermen and villagers also use it for drinking purposes and pisciculture of major carps and locally available fishes. No scientific study has been conducted on the reservoir so far. Therefore, the present study was undertaken to gain a basic knowledge of Rampur reservoir. This would not only enable the preliminary limnological knowledge but also help in exploring the possibilities for better management, development and augmentation of pisciculture.

Materials and Methods

Monthly sampling was carried out at two different sampling stations, namely A and B for one year (from April 1999 to March 2000). The samples were collected at 10 - 11 A. M. The physico-chemical parameters were analysed as per the procedure given in APHA 1981 and Trivedy and Goel 1986.

Results

Various physico-chemical parameters are shown in Table 1 and 2. The summary of the results is as under.

Colour

The water is almost courless. The water was turbid during monsoon. The colour as reflected from the reservoir was light green during winter and light brown during summer.

Temperature

The temperature varied from 18 °C to 29.5 °C. The minimum water temperature was recorded at station A i.e. 18 °C during January 2000 and maximum at stations B i.e. 29.5 °C during May 1999. During December 1999 the temperature was recorded 22.0 °C at both the stations.

Transparency

The transparency was recorded maximum during February - March at both the stations (60.5 cm Station A and 63 cm Station B). The minimum values were recorded during September at both the stations (24.0 cm station A and 25 Cm station B).

Turbidity

Turbidity is a measure of extent to which light is either scattered or absorbed by the suspended material in water. The turbidity ranged from 30.1 in March to 66.0 NTU in September at Station A and 30.9 in December to 68.0 NTU in September at spot B.

pH

Rampur reservoir maintained an alkaline pH throughout the investigation period and pH was recorded between 7.1 and 8.9. The pH was minimum i.e. 7.1 in the month of September 1999 and October 1999 at spot A and B respectively. The maximum value i.e. 8.90 was recorded in the month of May 1999 and July 1999 at spot A and B respectively.

Conductivity

The conductivity was recorded minimum during December 1999 i.e. 120mohs at spot B and maximum during September 1999 i.e. 240.9 mohs at spot A.

Alkalinity

The alkalinity showed higher value during summer and lower value during monsoon and winter.

Dissolved oxygen

Maximum dissolved Oxygen level (13.0 mg/L at station A and 12.0 mg/L at station B) atthe Rampur reservoir was recorded during May 1999. The minimum dissolved oxygen. level of 7.0 mg/L was recorded at station A and B during the month of September and August respectively.

Chloride

The chloride values varied from 4.0 mg/L (station A during December) to 9.2 mg/L (station B during May). From June onwards the values showed a decreasing trend up to December.

Table 1. Physico-chemical characteristics ofRampur reservoir at Spot A

Months	Colour Appearance	Temperature °C	pH	Turbidity NTU	Conductivity mhos/ cm	Dissolved Oxygen mg/ L	Transperancy cm	Chloride mg/L	Total Alkalinity mg/ L
April 1999	Light brown	27.5	8.5	38.5	140.2	11.5	54.9	8.4	261.5
May 1999	Light brown	29.0	8.7	40.0	141.7	13.0	53.2	9.0	289.0
June 1999	Light brown	27.0	8.8	44.9	199.8	12.0	49.1	7.5	258.0
July 1999	Turbid	26.5	8.9	50.0	201.5	10.5	41.6	7.0	254.5
August 1999	Turbid	25.9	7.7	62.5	208.2	7.5	32.1	6.8	232.8
September 1999	Turbid	24.5	7.6	68.0	240.9	7.0	24.0	5.9	215.9
October 1999	Turbid	24.1	7.1	54.1	192.2	7.9	38.0	5.5	165.0
November 1999	Light green	24.0	8.1	41.5	132.0	8.0	45.0	5.7	104.9
December 1999	Light green	22.0	8.3	30.9	124.0	8.3	51.5	4.0	104.0
January 2000	Light green	18.0	8.0	33.5	134.5	8.5	55.9	6.5	167.0
February 2000	Light green	20.0	8.2	31.0	135.4	8.5	60.5	7.8	172.0
March 2000	Light brown	25.0	8.4	37.2	138.9	8.7	58.0	8.2	220.0

Table 2. Physico-chemical characteristics of Rampur reservoir at Spot B

Months	Colour Appearance	Temperature °C	pH	Turbidity NTU	Conductivity mhos/ cm	Dissolved Oxygen mg/ L	Transperancy cm	Chloride mg/L	Total Alkalinity mg/ L
April 1999	Light brown	28.0	8.7	40.0	141.2	11.9	59.1	8.9	265.0
May 1999	Light brown	29.5	8.9	44.9	144.8	12.0	51.5	9.2	320.0
June 1999	Light brown	26.5	8.1	52.1	200.0	10.5	46.8	7.7	289.0
July 1999	Turbid	26.0	8.2	59.2	204.6	7.6	40.0	7.4	261.5
August 1999	Turbid	25.4	7.8	62.5	210.2	7.0	35.1	6.2	254.5
September 1999	Turbid	24.0	7.1	66.0	235.8	7.8	25.0	6.1	230.9
October 1999	Turbid	23.6	8.0	52.9	180.7	8.2	36.2	6.3	212.9
November 1999	Light green	23.2	8.1	44.6	128.0	8.2	43.0	6.8	105.0
December 1999	Light green	22.0	8.3	30.9	120.0	8.3	51.5	5.7	108.0
January 2000	Light green	18.1	8.1	34.1	123.8	8.6	56.0	7.0	170.0
February 2000	Light green	20.5	8.3	32.9	134.5	8.6	61.2	7.6	215.0
March 2000	Light green	25.5	8.5	30.1	136.9	9.2	63.0	8.6	235.0

Discussion

In the present study water temperature of Rampur reservoir varied from 18 °C to 29.5° C throughout the year. The fluctuations in the water temperature have relationships with the air temperature being maximum during summer and minimum during winter. Rao 1955and Saha and Pandit 1986 also reported same results.

Present observations showed minimum transparency during monsoon seasons and it increases subsequently. If we compare it with turbidity we find that it is inversely proportional to the turbidity. The low depth of visibility during monsoon is attributed to the highest turbidity of water caused by suspended silt and organic debris, similar trend was observed by Balkhi 1987 and Khanna *et al.* 1999. Bhatt and Negi 1985 also reported higher values of turbidity during monsoon for a river ecosystem.

Similarly, the highest value of conductivity during monsoon (September240 mohs/ cm at station A and 235.8 mohs/ cm at station B) may also be due to high turbidity, as indicated by Acre and Boyd 1980 that the conductivity of water increases with concentration of solids in the water.

The pH of Rampur reservoir water was found alkaline during the study period; Verma and Shukla 1967 also reported that freshwater bodies remain alkaline in nature.

Total alkalinity showed higher values during summer and a deep fall during monsoon. Goldman and Wetzel 1963 and Sharma 1992 have reported similar results.

Dissolved Oxygen is very essential for metabolism of all aquatic organisms for aerobic respiratory biochemistry (Wetzel 1975). The present investigation showed minimum value of dissolved oxygen during September and maximum during May. The higher values of oxygen during summer are associated mainly with the higher phytoplanktonic population (Bhatt and Negi 1985).

Present results showed lower concentration of chloride (4.0-9.2 mg/L) throughout the year indicating that the water is unpolluted from artificial sources. The low chloride content in natural water 4-10ppm only indicates the purity of water that is free from pollution (Shreenivasan 1965).

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Conservation of Horn Bills in Betul District of Madhya Pradesh, India

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Abstract

Among the birds the most contendus for the title of spectacular and even beautiful birds of Indian forests are Horn Bills with curious beaks and nesting habits, these giants are a naturalists delight in forest ranging from tropical deciduous to rain forest. Sixteen species of Horn bills occur with in Indian forests and neighboring countries. It is found that both the species Gray Horn Bill and Pide Horn Bill species are present in the forests of Betu district. The present paper is an attempt to report the habit, habitat and need of conservation of these birds.

Key words- Hornbills, Coracifornia

Introduction

Betul, because of its tropical, geographical location and diverse topography, has a rich and varied flora and fauna . A large number of bird species are found in Betul. A variety of seasonal, migratory and local birds can be seen here. Among the different families (likepodicipitidae, phalacrocoracidae, Thaskiomihidae) Bucerotidae, forest Horn Bill, is a rare and unique family. Gray Horn Bill is about two feet in length and its length itself is almost gray in colour. The crown is dark gray almost brown with light gray borders, wings too are brownish so is the tail.

Materials and Methods

The study of birds (Horn Bill) was conducted by field observations. Recorded birds are mostly based on information provided by the local tribes, the villages and forest personnel. Field observations were specially made in the area like Dharakhoh, Ranipur, Sarni, Bhoura and adjacent areas of Bori wild life century. All the relative data of species encountered during these surveys were enlisted. This list was tallied with a general survey conducted by the working plan officer of forest department and observer of such studies. Finally the checklist of these bird habits in Betul district was prepared.

Results

The gray Horn Bills has wider distribution then the Pied Horn Bills. One of the first things, likely to be strike is about its huge beak. This species differ from the majority of other family members in this manner, that it is présent both in open and deeper areas of forest. Besides these striking appearance Horn Bills are also known for their breeding habits. Nests of these birds are in cavities or hollows on the trees or rotting branches. In the forest area of Betul district few trees like Achar, Harra, Bahera, Neem, Imli, Beega, Chiroli, Landiya, Maharookh, Haldo, Amla, Pakar Palash, Seevan are the general trees with hollows, used by Horn Bills for nesting. Because of their large cavities that can be commensurate with their large body size, both the species prefer cavities that are just appropriate for a female. The researches have shown that the choice of nest tree is not random and Horn Bills prefer trees that are much larger then expected.

Generally, after mating, female Horn Bill at the time of nesting enter a national cavity in the trunk of the tree, thus she proceed to lay eggs. The moment she lays her first egg she starts sealing her self in the cavity by applying her dropping to the side of entrance of the hole. Droppings consist a sticky paste with fig seed and other waste. Only vertical slit is left. Male Horn Bill feed his imprisoned male. The male perches at the age of the nest or on a nearer branch and feed his mate with several dozens of fruits one by one.

Horn bills are the major elements of seed dispersion. These birds cover several square killometer in a day. Dispersion is also affected through the piles of dropped and madden seeds, that accumulates at the base of next tree. Some tree species with large fruits appears to depend exclusive on large frugivorous, such as Horn Bills for there seed dispersal. Although these birds are significant in their importance in forest ecosystem but their survival existence is highly threatened today due to human impact on their habitat. The Horn Bills preference for particles type of net trees is of great importance for their survival. Betul forest is one of the biggest sources of the wild fruit like Gular, Jamun, Achar, Mahua etc.

Although these birds are significant in forest ecosystem but there survival and existence is highly threatened in Betul today due to human impact on their habitat. Nesting trees are logged or cavities of nest holes removed as a part of forest operation. Poaching and capturing activities hits the population in many tribal areas of Betul district. Horn Bills cousque and feathers are used as symbol of power. Horn Bills are unmolested because of local awareness; a pair may cling like wastages to a small forest patch that contains their traditional nest site as in foothills of Mahadeva series of Satpuda. Our better-wooded part is the base of these series, which may provide alternatives for their rehabilitation.

Discussion

Horn Bills are mainly native of tropical rain forest due to fragmentation of these rain forest it needs new habitat. Wild life institute of India, in their annual report showed that plantation and commercial silviculture activities affected pied gray Horn Bills. Recent observations show that Betul forest patches provide an alternative home for these birds. Some modern conservation activities are launched in some parts of India, but these activities are not successful. We have to implement some more effective activities.

The Betul district is surrounded by rich forest area like Pachmari, Bori in north, Chhindwara in east and Melghat forest in south. It is serving as a undeclared corridor for Horn Bills, and now it is the appropriate time to declare Betul as a game reserve. Forest department, generally cutting the dead and dying trees in their various working circle managements, such shelters should not be marked for felling any more. As we know old trees are the only breeding shelters for Horn Bills, permission for exploiting these on the basis of soil conservation and silviculture aspects should not be permitted unless extensive and effective awareness programmes are carried out to aware the common man about their relationship with other forms.

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Baseline Studies of Biological Environment in EIA Project: Strategies and Examples

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Abstract

Baseline studies are the most commonly recognized element of Environmental Impact Assessment. The term usually refers to the collection of background information on the environmental setting for a proposed development project and it is normally one of the first activities undertaken in an EIA. Present paper deals with baseline studies for biological environment that are pre-requisite for the preparation of EIA report.

Kew Words: EIA, baseline studies, conservation

Introduction

The Indian subcontinent is one of the most fascinating ecological and geographical regions in the world.Here lies the nearly rainless desert of Thar and the rainiest place on earth-Cherrapunjee; the hot, salty Rann of Kutch and the permanently snow-bound peaks of the Himalayas; the wet coastal regions ofKerala and the islands of Andamans and Nicobar; the great lake of Chilka and the river system of Ganga-Brahmaputra.

This variety of ecological condition sustains a tremendous amount of diverse life forms. About 15000 species of plants (out of a world total of 250000) and 75000 animal species (out of a world total of 1.5 million) have been described from India. On two percent of the world's landmass, India possesses around five percent of the known living organisms on earth. The plants and animals provide food, clothing, medicines, raw materials and all other human needs including aesthetic pleasure and a livable atmosphere.

Man's dependence on the environment is greater than that of other organisms because in the pursuit of progress, greater comforts and security, he consumes larger amount of materials and energy than does any other organism. The proper management of the human use of living resources, i.e., conservation has, therefore, become very important today. Conservation of living resources has three specific objectives.

- To maintain essential ecological processes and life-supporting systems
- To preserve the diversity of species and the genetic resources-the absence of which in the long run threatens human survival itself
- To ensure sustainable utilization of natural resources, i.e. which assures survival of all species including human beings

The threat posed by continuing environmental degradation is no longer hypothetical, and it has serious economic and social implications for the future. In view of this, various steps have been taken in India, which is one of the few nations in the world to have given priority to environmental protection, not only in terms of its ancient heritage, but also in enshrining environmental concerns in the Directive Principles of Constitution and in Governmental actions. Environmental Impact Assessment (EIA) of developmental projects was first introduced in India in 1977-78 and Ministry of Environment and Forest (MOEF) is the nodal agency for EIA.

The MOEF published guidelines for preparation of EIA Statement along with questionnaires and checklists for industrial projects. Project proponents are required to provide relevant information as indicated in the guidelines along with the Environmental Impact Assessment Statement/Environmental Management Plan (EMP). The technical experts of MOEF make a preliminary scrutiny of the project proposals. After ensuring that the main aspects are covered, EIA reports are placed before the Appraisal Committees of Experts. The environmental clearance to development projects is subject to implementation of stipulated safeguards under the provisions of Environment (Protection) Act 1986, Forest (conservation) Act 1980, and other rules and regulations in force. The MOEF on January 27, 1993, brought out a draft notification under the Environment (Protection) Act 1986 making environmental clearance mandatory for expansion or modernization of any activity, if pollution load is

to exceed existing levels, and also for new projects listed in Schedule I of the notification. The notification was subsequently modified in May 1994.

Ecological Category

Species and population: Species and population are the basis for the ecological world, and their existence can be greatly influenced by changes in their environments. Care should be taken to describe those species and populations that can be identified. However, many species cannot be identified and how they will be affected by environmental changes is unknown. Further, certain species are used as indicators of healthy and unhealthy human environments as well as the status of the general environments (Table 1). These should be discussed in detail. Typical consideration might be

- With the removal of natural feeding sites, is the animal life of the area adversely affected?
- Does the effluent of the proposed project suggest impairment to aquatic life?
- Are the flora and fauna of the region significantly affected?

Communities and habitats: A group of species is a community. A habitat is the environment of a community. The existence of a variety of species and communities living together is the result of numerous and complex interaction. Major habitats include streams, lakes, estuaries, swamps, deserts, marshlands, forests, all components of some river basins etc. Different temperatures and overall climate affect different habitats for the various trees. Industrial development may physically destroy vegetation and wildlife by altering or destroying habitats. The effects may be both on the site itself as a result of construction and in the surroundings as a result of pollution from the development and secondary effects in the community. The impact of development on the flora and fauna (aquatic and terrestrial) should be evaluated by site surveys before and after development to determine the diversity and abundance of major species at various times of the year. To inventory, the populations within species, number of different species and their spread over should be noted. Typical considerations might be:

- Is the proposed action going to result in the destruction of rare and endangered species habitat?
- Are project-induced population shifts eliminating important biological communities of the local ecosystem?
- Are soil communities destroyed due to leachate at waste disposal site?

Ecosystem: An ecosystem is the entire natural life system of a local environment. River basins, forests and plains are typical natural systems in which ecosystems function. The fundamentals of most ecosystems are known, but data are lacking on the numerous processes and interactions that occur. Thus, in the ecosystem analysis, assumptions are made and the justifications for such assumptions are described.

Biodiversity: The term 'biodiversity' is commonly used to describe the number, variety and variability of living organisms. Perhaps because the living world is most widely considered in terms of species, biodiversity is very commonly used as a synonym of species diversity, in particular of 'species richness' which is the number of species in a site or habitat. Conservation of biological diversity is a form of natural resources management, which has as its primary goal maintaining the long-term potential of world biological resources to meet the needs and aspirations of future generations- a fundamental principle of sustainable development.

Ideally, any implications for biological diversity will be among the major issues identified during the screening of proposed project. A simple checklist to assist in early identification of biological diversity issues is provided below:

- Identify the specific types of ecosystem the proposed projects will affect (tropical forest, wet land etc.). Are any of them wild lands of special concern or designated natural sites of national or international importance?
- What are biological features of the ecosystems; e.g. habitat for endangered species, or only breeding and nesting area for a particular species.
- Determine the general nature of the project's impact on ecosystems, e.g. deforestation, flooding, draining, changing hydrological regime, facilitating human access etc.
- Assess the significance of likely negative impacts relative to
    - Total area of ecosystem type in region and/or country (e.g. project will destroy approx. 10% of nations remaining lowland forest)

- Cumulative effects and trends for ecosystem type (e.g. tidal wetlands area is being lost in the country at an annual rate of 3% a year; this project and two other harbor facilities projects planned for the coastal zone will involve a total of 6% of the remaining area)

Table 1. Usefulness of various Taxonomic groups as biological indicator

Group	Distribution (Species Patterns)	Taxonomy	Working level	Ease	Sampling	Movement	Organics/ Nutrients	Metals	General Water Chemistry	Interpretative Strength
Bacteria	Cosmopolitan	Incomplete	Genus, Species	±	Descriptive, Statistical	Generally Stationary	✓		✓	Limited by sampling or analysis difficulties, high indicator strength
Fungi	Cosmopolitan	Incomplete	Genus	-	Descriptive	Generally Stationary	✓			Limited by sampling or analysis difficulties
Protozoa	Cosmopolitan	Complete	Species	+	Descriptive	Generally Stationary	✓	✓	✓	Ecological relationships poorly understood, saprobic importance
Algae										
Periphyton	Cosmopolitan	Approximately complete	Species	±	Descriptive, approximately statistical	Generally Stationary	∽	✓	✓	Good indication of water chemistry and enrichment
Phytoplankton	Cosmopolitan	Approximately complete	Species	±	Descriptive, approximately statistical	Mobile	∽	✓	✓	Good indication of water chemistry and enrichment
Macrophytes	Geographic regions	Complete	Species	-SS	Descriptive, approximately statistical	Sessile			✓	Limited by sampling or analysis difficulties
Invertebrates										
Zooplankton	Cosmopolitan, Geographic regions	Approximately complete	Genus	-	Descriptive. Approximately statistical	Mobile		✓	✓	Limited by sampling or analysis difficulties, Ecological relationship poorly understood-high value in lentic ecosystems, early trophic effects
Insects	Geographic Regions limited	Incomplete	Genus. Family	-	Descriptive	Sessile		✓	✓	Ecological relationships
Molluscs	Geographic Regions limited	Approximately complete	Species	+	Descriptive, Statistical	Sessile	∽		✓	Site specific indicators
Worms	Cosmopolitan	Incomplete	Species	-	Descriptive				✓	
Vertebrates										
Fish	Geographic regions limited	Incomplete (Life stage limited)	Species	+	Descriptive	Mobile	✓	✓	✓	Limited by sampling difficulties and early life stage identification
Mammals	Geographic regions limited	Complete		+	Descriptive	Mobile				

+ : relative ease of identification; - : difficult identification; ± group or life stage difficult identification; -SS: difficult identification is season specific; ✓ :taxa used to indicate pollution effects;
∽ : mixed, group or life stage specific

Water Environment

Water is one of the necessities to life, as we know it. All flora and fauna life cycles use it and generate wastes. These wastes have now begun to inhibit the use of water for its intended purpose. Thus, water of a region must be assessed as to its quality, quantity and availability. Before conducting a water quality impact assessment, all applicable water quality criteria and standards must be known. 'Water quality criteria' as distinguished from standards, are defined as the levels of specific concentrations of constituents that are expected, if not exceeded, to assure the suitability of water for specific uses. However, barring microbiological parameters, specific standard levels of different biota are not recommended under surface water quality criteria in India.

The water quality team must scan the environment in the area of the proposed project and review the characteristics of the project. The objective is to determine possible water quality impacts, which might result from the project, and to identify sensitive or critical environmental areas. Surface and groundwater resources should be identified and their general biological characteristics should be evaluated. The plan should address

- Location of sampling stations.
- Parameters to be analysed and identification of sampling equipments.
- Time schedules, including time of day, time of year and frequency.
- Method of data collection.
- Sample handling, preservation and transport before analysis.

Studies should lead to selection of certain biological indicators that will enable the assessment team to adequately describe the environment. Sensitive organisms must be described in detail, particularly if the proposed action could have an impact upon such organisms. The major parameters need to be taken care are cited below.

Primary productivity: It is dependent on the photosynthesis of green plants principally of phytoplankton in all water bodies including sea. Light and dark bottle technique as described in standard can be applied.

Chlorophyll: Different types of pigments are found in algae, which are classified in to chlorophyll –a, chlorophyll –b, chlorophyll –c, xanthophylls and beta carotene. Among these, chlorophyll –a and beta carotenes are the principal pigments which are present in all classes of algae. Extractions of phytoplankton pigments in acetone and their quantification is considered as a standard and valid method for assessing the phytoplankton standing crop of any ecosystem.

Enumeration: Each phytoplankton, zooplankton, macrobenthos, meiobenthos and other nekton species in aquatic bodies should be assessed through count at unit area/volume.

Biomass: Biomass is the quantitative estimation of the total mass of living organisms within a given area or volume. Direct weight of comparatively larger species or chlorophyll (for algae) /carbon/cell volume method for smaller flora/fauna can be adopted.

Diversity Index: Following are the diversity indexes

a) Shannon Weiner Diversity Index (d) – it is a measure of diversity which takes into account the total count and individual count in a sample and is expressed as

$$d = -\Sigma(ni/N)\ Log_2^{(ni/N)}$$

where,
ni=number of individuals of each species,
N=total number of individuals of all species

b) Diversity index (D) of Margalef

$$D = \frac{S-1}{Log_e N}$$

Where, S=total number of individuals

c) Equitability index (Pielou) (E)
$E=d/\log_2 S$

where,
d=Shannon Weiner diversity index,
S=number of species in the community

Similarity index: This index (S) is necessary while comparing similarity or dissimilarity of communities among different sampling points

$S=2C/(A+B)$

where,
C=number of species in sample common to both samples
A=number of species in sample A
B=number of species in sample B

Fisheries: Different varieties of fishes comprise as principal community of any aquatic ecosystem. Therefore, detailed investigations on fisheries are necessary in any EIA study. The investigator should first be acquainted with the following aspects.

- What is the current fish community structure (biological integrity), and does it indicate poor or good fishery health?
- Are the fish diseased, parasitized, or deformed? If so, to what extent?
- Do the fish contains toxic substance? If so, to what extent?
- What are the distribution and extent of the sport and commercial fishes?
- Is the growth of the fish is in accordance to normal enlargement of both length and weight?
- Do the fish mature and breed in concerned water body?

The studies should also cover different fishing instruments (crafts and gears), harvest of various species, feeding habits of the organisms, condition factors, fecundity, food values, fishermen's social welfare etc.

Food chain: The essential components of a grazing food chain are the following fivetrophic levels

- Primary producers comprising phytoplankton
- Herbivores (including herbivorous fish), primarily includes zooplankton which graze upon phytoplankton
- First stage carnivores, comprising small carnivorous fish, insects, mollusks etc.
- Second stage carnivores comprising larger predatory fish which prey upon smaller carnivorous fish, and
- Third stage carnivores consisting of the top ranking larger predatory fish and birds.

Basically the food chain holds true in all waters fresh, brackish and salty waters of the seas and oceans.

Trophic structure and ecology pyramids: The occurrence of food chain phenomenon in nature results in a tropic stratification of biotic communities in aquatic ecosystems. Each of the stage of the food chain is called trophic level. The trophic structure of the ecosystem can be rendered into pyramid that can be expressed in the form of number, biomass or energy.

Terrestrial Environment

Assessment of the biological portion of the terrestrial environments must include what are present, their values and response to impacts. Various methods are available to describe the natural community and its components. The assessment should provide a description of community uniqueness, the dominant species, and an evaluation

of rare and endangered species. Further, the assessment should consider the vulnerability to and the outcome of various human impacts. The biologist should obtain answers to a series of questions as mentioned below before the actual biotic assessment study begins

- What is the geographic size of the proposed project site?
- What part of the site is involved in the proposed projects?
- What is the type of project?
- Is the project to be short-term final or long-term incremental?
- If long-term incremental, is the biotic assessment to be done in increments or at one time?
- What is the biotic character of the part of the site involved?
- How will the project influence the plants?
- How will the project influence the animals?
- How will the project influence the ecology of the various habitats?
- What information exists on the biota of the area?

Baseline studies should list the dominant plants and animals species found on the proposed site, as well as possible rare and endangered species. These should be discussed in a regional context as to their uniqueness or commonness. Sensitive or fragile habitats and their associated species should be studied and described in greater detail in order to establish baseline data that can be used to detect unforeseen projects impacts.

Some biotic areas are sufficiently researched so that secondary source can be used rather than detailed on-site studies. Although such secondary sources may have a cost advantage, they should be used with caution since biological communities change continuously as does the status of certain species.

Plant survey: Vegetation can be assessed in several descriptive ways. A species list includes both common and scientific names of the plants found or suspected to occur in the study area. The list is developed by site visits and by consulting published literature. Secondary sources must be referenced. Since the species list does not convey the relation between plants and the environment, it should be appended in the report.

The common tools employed in vegetation assessment are abundance scale (Table 2) based on species cover, importance value index (IVI) based on relative density, relative dominance and relative frequency, diversity indices as described under aquatic environment assessment, biomass, economics etc. Common measures of importance of terrestrial plant species in a community are depicted in Table 3. The following steps are measured for calculating IVI of plant species.

Density = No of species A/ area sampled

Dominance = Total cover or basal area of species A/ area sampled

Frequency = Number of plots in which species A occurs/ total number of plots sampled

Relative density = (density of species A/ total density of all species) * 100

Relative dominance = (dominance of species A/ total dominance of all species) * 100

Relative frequency = (frequency of species A/ total frequency of all species) * 100

Importance value index = (relative density + relative dominance + relative frequency)/ 3

Larger quadrates, transects, line intercepts and plotless methods are used to evaluate perennial shrub or tree community types. Transects may be of any desired dimension, but usually 10 or 100 times as long as wide. One meter is a convenient width since it allows for accurate accounting of each plant. Line intercepts are linear plots usually 10 to 100 meters in length. Under point quarter plotess method, a series of points randomly determined. Each point is divided into four 90° quadrants. The tree at each quadrant is identified, its distance from the point is measured, and its basal area is determined. Minimums of 50 such point tallies are generally taken.

Table 2. The Braun-Blanquet and Domin Scales for Cover Abundance

Braun-Blanquet		Domin	
r one or a few individuals		+	one individual
+ ocassional and less than 5 % of total plot area		1	rare
1 abundant and with very low cover, or less abundant but with high cover; in any case less than 5 % cover of total plot area		2	sparse
2 very abundant and less than 5 % cover, or 5-25 % cover of total plot area		3	less than 5 % frequent
2 m very abundant		4	5-10 %
2a 5-12.5 % cover, irrespective of individuals		5	11-25 %
2b 12.5 – 25 % cover, irrespective of number of individuals		6	26-33 %
3 25 – 50 % cover of total plot area, irrespective of number of individuals		7	34 – 50 %
4 50 – 75 % cover of total plot area, irrespective of number of individuals		8	51 – 75 %
5 75 – 100 % cover of total plot area, irrespective of individuals		9	76-90 %
		10	91–100 %
Sociability			
1. Growing solitary, singly			
2. Growing in small groups of a fiew individuals, or in small tussocks			
3. Growing in small patches, cushins, or large tssocks; hummock builders			
4. Growing in extensive patches, carpets, or broken mats			
5. Growing in great crowds of extensive mats completely covering the whole plot area; mostlypur populations			
Phenophase			
v. (Vegetation)			
fl. (flowers)			
fr. (Fruits)			
e.g. Scirpus maritime 2.3.v (cover sociability phenophase)			

Table 3. Common measures of importance of terrestrial plant species in a community

Important Measures	Definition
Density	Number of individuals per unit area
Foliar cover	Percent of ground surface covered by leaves
Individual overlay	Sum of cover percent counting each individual's canopy separately (can exceed 100 %)
Projective foliar cover	Percent of ground surface covered one or more times by leaves of the species (can not exceed 100 %)
Leaf area index	Average number leaves stacked above any point on the ground
Basal area	Cross sectional area of tree trunks at breast height (1.37 m)
Frequency	Percent of small sample plots within a study site in which a species occur
Constancy	Percent of large study sites of the same size, out of the total sampled, in which the species occurs
Presence	Percent of large study sites in which a species occurs when plots are not of the same size
Net primary production	Net increase in biomass per unit time before herbivory or decay

Animal survey: The animal life (fauna) of an area is dependent upon the vegetation, and there are countless relationships between the species composing an animal community. The choice of animal survey method varies with the extent and purpose of the study and with the composition of the animal community involved, such as insects, birds and mammals.

Animal community can be assessed by observing the fauna directly. A species list should be prepared by walking through the area. A trained biologist can determine the presence of certain animal species by recognizing animal signs, such as tracks, scats, bones etc. published lists and description of animal species should be consulted.

Insects and other arthropods require aerial and sweep nets for collection during flying condition in day. Birds are best studied by direct observation with the help of binoculars. Bird calls are meaningful only to a well-trained bird watchers. Pre-selecting routes to be walked through the study site can systematize the survey of birds. These routes of a given distance, time, direction and in representative habitats, make it possible to quantify somewhat the abundance and range of each species. Roadside counts along roads and highways and also along existing or proposed power-line, pipelines, railroads and other right of ways are used for determining count indices. For example, a count would be made at ½- km intervals for a total distance of 5 km. The data are expressed as a census index defined by

Census index = N/D

Where,
N=Number of individuals of each species seen
D=Distance in km traveled

Mammals and other vertebrates such as reptiles and amphibians can be studied directly by observation or collection, or indirectly through their tracks, homes, or sound.

Rare and Endangered Flora and Fauna

Botanical survey of India has published a list of 134 most threatened plant species, of which 99 are in the Himalayas and the northeast. Twenty eight species of orchids are endangered. Northeast India has the third largest resources of plants in the world for any area of similar size. About 50 percent of the total flora of India comes from this region.

The first comprehensive listing of endangered wild life species in India was complied in the wildlife (protection) Act, 1972 which provides for protection of threatened faunal species from indiscriminate hunting. Schedule I of the Act identifies 77 mammals, 25 reptiles, amphibians, 51 birds and 130 crustaceans and insects as rare and highly endangered species, which are totally protected throughout the land.

Wildlife conservation is a total concept involving animals, plants, microorganisms and soil, and also others physical elements of environment on which they live and depend. In view of this, baseline studies under EIA should cover detailed list of the animals and plants, their biology, habitat, behaviour (feeding, migration etc. of animals) and features.

Base Line Studies on Aquatic Environment : A Case Study

The comprehensive work carried out during 1991-92 for a project of Thermal Power Station in West Coast of India has been briefed below:

This site was selected for the installation of a 500 MW coal based thermal power station, which is surrounded by three creeks on three sides. The comprehensive studies dealt with seasonal (summer, post monsoon and winter) monitoring of the creeks, development of food webtrophic levels and pyramids as well as assessment of mangroves in surrounding wet lands based on reconnaissance survey, 12 sampling points and frequency of samples were selected.

Primary producer: In situ primary productivity experiments following dark and light bottle methods were carried out on two consecutive days in each season at different sampling points. Gross primary productivity (0.0867, 0.195 and 0.208 gm Cm^{-2} day^{-1} during summer, post monsoon and winter respectively) of the creek waters appeared to be negligible. This has further been supported by poor chlorophyll of the algae contents. While total algal population varied between 380 and 5000 cells per 100 ml, bacillariophyceae represented as principal group. In general, variations in total counts and composition of phytoplankton recorded during high tide and low tide in three seasons were not remarkable. As compared to mouth of creek (2.4-3.0), SW diversity indices varied widely (1.31-3.43) among remaining samples of the creeks. While applying similarity indices, phytoplankton species composition indicated higher similarity among different samples of high tide in summer and of low tide in winter seasons. Each algal species was assessed further on the basis of density, biomass and frequency of occurrence computed together as absolute importance value. Among 29 species of phytoplankton,

N.closterium, *Coccosphere* sp. and *Navicula* sp. scored highest importance values (absolute) in summer, post monsoon and winter seasons respectively. The habitat, based on preference and availability of phytoplankton was evaluated through importance value (habitat) and y-diversity. It has been estimated that *N. closterium* followed by *Navicula* sp., *Coccosphere* sp., *Oscillatoria* sp. etc. were the most acceptable phytoplankton in the creek habitat. Presence of species like *Rhizosolenia* sp., *Mougeotia* sp., *Gomphonema* sp. was susceptible in the area.

Zooplankton: Zooplankton were represented by 89 species from 28 major taxa, of which copepoda dominated in all 62 samples analysed. Total count was varied among seasons, tides, banks, depth and time of sample collection. Average zooplankton count in high tide sample was less that of low tide sample. Like phytoplankton, SW diversity indices of zooplankton fluctuated widely (0.39 to 3.55) in creeks as compared to open sea (0.65 to 2.27). Moderate similarities of zooplankton species among different sampling points have been recorded. While assessing importance of individual zooplankton, it appeared that barring a few, namely copepod nauplius, *Oithona* sp., *Paracalanus* sp., *Hemisiriella* sp. and *Acartia* sp., zooplankton of the creeks either did not appear in all the three seasons or their density, frequency and biomass were of poor significance when available throughout the year. Four plankters, namely puffer fish larva, *Liriope* sp., *Planaxis* sp. and *Oikopleura* sp. emerged as most sensitive organism in the creeks.

Benthos: Benthic fauna was segregated to meio- and macrobenthos, which were represented by 20 taxonomic groups. Density of benthos varied among banks and sampling points. Based on diversity and density, nematodes represented as the most dominant meiobenthos in summer but foraminiferas outnumbered others in post monsoon and winter seasons. SW diversity indices of benthic organisms varied between 0.92 and 4.23. However, taxonomic composition indicated higher percentage of dissimilarity among different locations. Based on concept that meiobenthos are 5 times more metabolically active than macrobenthos, metabolic indices (MI) of benthos at different sampling points have been estimated.

Fisheries: In order to have baseline status of fisheries during precommissioning phase of the thermal power station, fish and fisheries of the creeks have been studied in detail with special reference to crafts and gears used, fishing, harvest of fin and shell fish, diversity index, importance value of each species, condition factor, length-weight relationship, feeding habit, gonosomatic index, fecundity, habitat evaluation, heavy metal contamination, calorific value of edible tissues, fish farms and fisheries co- operative societies. All these parameters are variable with altered environment condition and the data generated will be useful for comparison with those of post commissioning phase.

Test netting by bag net was employed during different tides at different sampling stations. Harvest with respect to diverse fish species and total weight was generally more in between low tide and high creeks along with water current. However, remarkable size-related catch among sampling points/ tides was not recorded. Altogether 82 varieties of fishes were harvested.

Prawns, which contributed 8.16, 2.56 and 2.56 percent of total harvest during summer, post monsoon and winter seasons respectively were represented by 12 species. In general respectively were represented by 12 species. In general, harvested penaeid prawns were comparatively larger in size from those of nonpenaeids. The survey indicated that nonpenaeids do enter the creeks in between low tide and high tide and penaeide, which generally migrate from sea to creeks at juvenile stages, prefer creek region and was trapped while moving towards sea in between high tide and low tide.

Besides fish and prawns, particulars of other macrofauna including trash fish were investigated. Cephalopods, represented by *Loligo* sp. and *Octopus* sp., contributed only 0.40 and 1.23 percent respectively of total catch in summer. The values decreased marginally in winters but increased substantially in post monsoon seasons.Cuttle fish (*Sepia* sp.) were harvested only in post monsoon season. However, a sizable portion (33, 9 and 82 percent in summer, post monsoon and winters seasons respectively) of total harvest was shared by relatively little fin and shellfishes, called trash fish. Other macrofauna captured by fishing nets were crabs, squilla, jellyfish and sea snakes.

Diversity indices for fish and prawn species have been determined on the basis of number and weight. Generally index values for fishes were more from those of prawns because of diverse species composition of the former. Attempt was also made to estimate composite index of community well being (I_{WB}), often followed for water bodies of U.S, for fish and prawn of the creeks. I_{WB} values estimated for the creeks were comparatively more

from those of Wabash River, Indiana, determined during 1968-81. Importance values of all fish and prawn species were assessed. The fish *Lepturacanthus savala* followed by *Harpodon nehereus* and the prawn *Metapenaeus brevicornis* followed by *Metapenaeus monoceros* emerged as most important species in respective groups. On the other hand, *Ambassis commersonii* followed by *Cynoglossus lingua* and *Hippolysmata vittata* followed by *Penaeus monodon* were the least important fish and prawn species respectively. Condition factor (K) and length-weigth relationship followed the equation "W=a Ln" are good indicators of change in habitat, season, sex and health of fish and prawn species. Baseline conditions (K) of 82 varieties of fishes and L-W regression equations of major fish and prawn harvested during three seasons were studied. The varieties with isometric and allometric growth have also been identified. Feeding habits of the fish and prawn of study area have been studied critically with special reference to morphology of alimentary canal, stomach volume and gut contents. Postmortem examinations revealed that most of the fishes were voracious eaters with 3 to 11 percent of total body weight as stomach contents. Gonosomatic index (GSI), a factor of gonad, was studied because of its variable nature with altered abiotic characteristics of the environment. GSI were maximum for the fishes *B. dussumieri* and prawn *H. ensirostris*. Microscopic examination of eggs revealed that majority of the fish and prawn varieties were not in sexually matured stage.

The preference of the creek habitat by the fish and prawn was evaluated through density and frequently in catch. This habitat was mostly preferred by fish *L. savala* followed by *H. nehereus*, *P. elongata*, *S. biauritus* etc. and prawn *M. brevicornis* followed by *M. monoceros*, *P. sculptilis* etc. *A. commersonii* and *H. vittata* were the most sensitive fish and prawn respectively of this habitat.

Selective heavy metals (Cd, Cr, Cu, Pb, Fe, Zn, Mn and Ni) were analysed from edible tissues of certain fin and shell fishes of the creeks. The order of metal accumulation was Fe>Zn>Mn>Cr>Cu>Pb>Ni>Cd. However, metal accumulations in fishes and prawns under study was less while comparing to those published in literature from different regions of oceans. Moisture contents and calorific values of selective fish and prawn were estimated. The nutritive calories for fish muscles varied between 3.79 and 4.85, 4.20 and 5.40 cal gm-1 dry wt in summer and post monsoon seasons respectively. The same for prawn fluctuated from 4.07 to 5.06 gm-1 dry wt in summer.

Avifauna: Studies on shore birds which feed mostly on fish, invertebrates, offal etc., at three regions of the creek indicated that Black-headed gull, Little stint and Indian reef heron were dominant at three different creeks. Altogether 17 species of avifauna were recorded, of which White bellied sea eagle is endangered species.

Tropic levels: Tropic status of the ecosystem has been evaluated on the basis of feeding habits of the organisms. Herbivorous zooplankton (consumer 1) indiscriminately ingests phytoplankton, the producer (P) and organic matter suspended in seawater. The third trophic level (C2) in creeks was mostly occupied by macroplankton (chaetognaths, polychaete worms, larvae and adult of various crustaceans and gastropods etc.) as well as macrophagous nekton (various decapods and plankton feeding fish). Trophic levels IV (C3) and V (C4) of this region were occupied by predator fish, cephalopods and shore birds. While computing biomass of each trophic level, semi-alternating pattern of pyramids were obtained in all the three seasons. The ecological efficiencies (percentage biomass transfer in succeeding trophic levels) of the region measured were 1584, 486, 13 and 10 percent at C1 through C4 respectively during summer. The same for other seasons in aforementioned order were estimated as 3796, 127, 38 and 14 (post monsoon) and 11358, 57, 8 and 18 (winter). In food chain trophic level, meiobenthos (C1), which contributed about 25 percent of total fauna, had a significant role. Since concentration of producer (P) was poor in creeks, detritus was the principle source of food for meiobenthos.

Other aspects: The creek water exhibited negligible number of coliform and faecal coliform group of organisms indicating marginal contamination of faecal pollution. Mangroves and halophytes around the creeks have been studied in detail. Among the vegetation *Avicennia marina* was the most important plant. Plantation of Mangroves in barren areas by the project proponent has been recorded.

Base Line Studies on Terrestrial Environment : A Case Study

The base line studies carried out during 1990 –91 towards terrestrial environment under a project pertaining to construction of a dam on a river have been summarized below. The project proponent proposed to develop additional source of water by creating an impoundage through the construction of a dam in between existing upper and lower dams on a river

Vegetation Study: Six forests from submergence and catchment areas were selected within 15 km radius at different directions around proposed dam site. Observations were made at each sampling point pertaining to girth, perimeter, tree height, canopy cover of the trees, types of shrubs, herbs etc. Information towards list of vegetation, forest nursery etc. was collected from concerned forest department and botanical survey of India. Reserved forests on upstream (E) and downstream (f) sides of the existing dam at downstream of the river were considered as reference points.

To sample the vegetations, random plotless sampling methods were adopted. Sampling locations were randomly selected at hill tops, on the slopes and in the valleys between hills. The following six associations of trees were observed in study area.

- Teak- ain- kuda- karvand
- Teak- khair-kuda-takla
- Teak-dhavada-kuda-takla
- Ain-khair-koshimb-karvand
- Kakad-shemat-kuda-takla
- Ain-bonda

The common plants under top canopy trees, second storey trees,s hrubs, herbs and climbers were recorded. Information towards different injuries like setting fire, illegal cutting of trees, removal of leaf litters etc. was collected. Among the six forests, surveyed, the forestA exhibited maximum diversity index with richest floristic distribution. Barring forest B and F, *Tectona grandis* emerged as the most dominant species in the forests. Details of floristics, similarity indices, equitability indices, IVI, canopy, S-W diversity indices etc. have been evaluated. While Table 4 depicts different features of the six forests, IVI of various tree species of a representative forest (B) are presented in Table 5. Similarity indices indicated maximum resemblance among the trees between upstream and downstream forests of existing dam.

Table 4. Diversity and features of tree species in different forests around proposed dam site

Sr. No	Parameters	Forests					
		A	B	C	D	E	F
1.	Diversity index	3.610	2.730	2.160	3.00	3.200	3.490
2.	Equitability	0.905	0.864	0.930	1.00	0.966	0.896
3.	Density (ha^{-1})	254.390	60.000	51.020	21.12	57.470	117.450
4.	Most important tree	*Tectona grandis*	*Anogeissus latifolia*	*Tectona grandis*	*Tectona grandis*	*Terminalia tomentosa*	*Tectona grandis*
5.	Average height (m)	5.610	5.090	6.370	5.870	7.650	10.360
6.	Average cover area per plant (m^2)	23.000	29.000	15.110	33.110	27.180	38.800
7.	Source* of cover abundance class	4.000	2 b	2 a	2 a	2 b	3.000

The source 2a, 2b. 3 and 4 indicate total cover of 5 –12.5, 12.5-25, 25-50 and 50-75 % respectively of Braun-Blanquet scale.

Table 5. Structure of forest: B

Sr. No.	Name of Species	Density Tree/ ha	Relative density (%)	Relative dominance (%)	Relative frequency (%)	Impornace value index (%)
1.	*Carissa caranda*	3.75	6.25	0.59	7.69	4.84
2.	*Tectona grandis*	3.75	6.25	4.87	7.69	6.27
3.	*Anogessus latifolia*	22.50	37.5	18.83	30.77	29.03
4.	*Bridelia retusa*	3.75	6.25	2.78	7.69	5.57
5.	*Mangifera indica*	11.25	18.75	42.43	15.38	25.52
6.	*Terminalia arjuna*	3.75	6.25	18.20	7.69	10.71
7.	*Bombax malabarica*	3.75	6.25	1.22	7.69	5.05
8.	*Lagerstrocemia parviflora*	3.75	6.25	6.20	7.69	6.71
9.	*Grewia latifolia*	3.75	6.25	4.87	7.69	6.27

Fauna Assessment: Field studies were carried out on different routes at three directions mentioned below:

Route 1 : 9 km
Route 2 : 10 km
Route 3 : 16 km

Road side counts were made preferring fixed-width transects. Community studies were carried out in which the census of a mixed population is intended for comparison with similar lists from other localities. The data were subjected to detailed analysis following dominance, census, species, richness, species diversity and similarity indices.

Dominance index $D = (ni/N) * 100$

Where,
ni=count of individual species recorded
N=total count of all species

Census index $C = (ni/M)$

Where,
ni= count of individual species recorded
M=area covered

Species richness index

It is expressed as total number of species recorded at each sampling route.

Diverse groups of birds representing 30 species were recorded in study area. Higher varieties of avifauna as encountered along route 2 might be attributed to vast area of forest, human inhabitation and agricultural fields. Studies on percent dominance and census index revealed that values were more for houses swift along routes 1 and 3 and for domestic hen along route 2. It was observed that the values did not differ remarkably, when distribution patterns of the birds, present along with different routes, were compared through similarity indices. Similarity indices between 1-2, 2-3 and 1-3 routes were 0.59, 0.56 and 0.60 respectively indicating moderately similar types of birds on different routes. Maximum and minimum diversity indices were recorded along routes 2 (4.775) and 1 (3.450) respectively. Distribution of animals within specific area (census index) differed widely along routes 2 and 3. Lowest census index along route 3 might be attributed to less number of villages and absence of agricultural fields.

The study area is having one game sanctuary. The details of area, list of animals, their census, water holes, feeding habits, movements and behavior were recorded from respective Government organizations and field visits. The animals belonged to schedules I (absolute protection), II (special game), III (big game) and IV (small game) were recorded.

MEMBERSHIP INFORMATION

Membership for Action for Sustainable, Efficacious Development and Awareness (ASEA), India is open for all those interested in the field of environment. There are three types of memberships available i.e. Annual Membership, Life Membership and Fellow Membership. Fellows of ASEA are privileged to write FASEA with their names. All the members are entitled to get Environment Conservation Journal Free and are entitled to submit their papers/ articles for publication in the Journal.

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All remittance must be made by DD in the name of Action for Sustainable, Efficacious Development and Awareness payable at Rishikesh and be sent to Dr. Ashutosh Gautam, IGL Township, India Glycols Limited, Bazpur Road, Kashipur – 244 713, U.P., India.