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EFFECT OF SOME HEAVY METALS ON *LAMPITO MAURITII* KINBERG (ANNELIDA : OLIGOCHAETA) IN MUNICIPAL WASTES DISPOSAL SITE AND A RESERVE FOREST FLOOR SITE OF WEST BENGAL, INDIA

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INTRODUCTION

As a result of the increasing interest paid to the recycling of wastewater, municipal wastes and sewage sludge in agricultural practice, it becomes necessary to study the uptake of heavy metals in invertebrates in general and earthworm in particular.

It is evident that earthworm can accumulate heavy metals from surrounding polluted soils and other media in their body (Gish and Christensen, 1973; van Hook, 1974; van Rhee, 1975; Ireland, 1979, 1983; Ash and Lee, 1980; Beyer, 1981; Beyer *et al.* 1982; Kruse and Barrett, 1985). But no such work has been carried out in India. To fill up this lacuna the present study has been conducted with the following objectives :

To determine whether this dominant species of *L. mauritii* could be use to absorb the heavy metals in contaminated soil and to compare them with a less polluted controlled reserve forest floor.

MATERIALS AND METHODS

Earthworm samples were collected month wise at random by digging and hand sorting method. Collected samples were repeatedly washed in water and then kept in double distilled water for 72 hours to evacuate soil from its gut. After that period earthworm samples were preserved in 10% formalin. Preserved samples were washed in double distilled water and then oven dried at 65°C for 48 hours Dried samples were crushed, weighed on a microbalance and acid (Nitric and Perchloric) digested on a hot plate.

KEYWORDS : Earthworm, *Lampito mauritii*, Heavy metals, Cadmium, Zinc, Lead, Copper, Wastes disposal site.

During collection of earthworm, soil samples were also collected at random. Collected soil samples of each month was air dried, crushed and mixed thoroughly. Acid digestion of soil samples were done in the same way.

Analysis of Zn, Cd, Pb and Cu was done using a Varian Techtron AA-575 atomic absorption spectrophotometer in R.S.I.C., Bose Institute, Kolkata. Wavelength (nm), Slit (nm) and Lamp current (mA) was used 213.9, 1.0, 5; 228.8, 0.5, 3.5; 217.0, 1.0, edl and 324.8, 0.5, 3.5 for Zn, Cd, Pb and Cu respectively.

p^H of the soil was determined by the electronic p^H meter (Model No. 335–Systronics). Electrical conductivity of the soil was determined by direct reading conductivity meter (Model No. 304–Systronics, conductivity cell type C. D-10). Organic carbon content of the soil was determined by "Rapid Titration Method" (Walkley and Black, 1934).

The Statistical analysis has been conducted by using BMDP Statistical Software, Inc.

CHARACTERISTICS OF THE STUDY SITES

Site–I : *Dhapa-Municipal wastes disposal site (DP)*

The site is dumping ground of city wastes, located by the side of Eastern Metropolitan By Pass, Kolkata. "Organic Fertilizer Pvt. Ltd." and 'Conversation of City Solid Wastes into Organic Fertilizer in Collaboration with Kolkata Municipal Corporation and Eastern Fertilizer Pvt. Ltd.' demarcate the area. The main constituents of the dumped materials were household wastes, industrial effluents and the residues of vegetables. Some parts of this sampling site regularly used for cultivation of different seasonal vegetables like cauliflower, maize, cucurbita, lettuce, red green leafy vegetables, cabbage etc. The soil is alluvial in nature, silty sand to sandy in texture, blackish in colour.

Site–II : *Bethuadhari Reserve Forest (BRF)*

It is a man made forest, located at Bethuadahari, by the side of NH-34, about 138 km. North of Kolkata, in the district of Nadia, at the eastern part of West-Bengal is being situated in the Gangetic plain. Tropic of cancer runs across the middle of the district. Annual rainfall ranges from 77-84.70 cm. The forest contains major trees like, *Shorea robusta*, *Tectona grandis*, *Dalbergia sisso*, *Ficus religiosa*, *Mangifera indica* and *Azadirachat indica* and under growths like, *Sporobolus diander*, *Dichanthium annulatum*, *Eragrostis brachyphylla*, *Digitana marginata. D. royleana*, *Euphoriba hirta* and *Lantana camara.* The soil is alluvial in nature, blackish brown in colour and sandy silt in texture.

RESULTS

Cadmium, zinc, lead and copper were present with in the range between 2.5–6.25 ppm., 550–750 ppm. 250–410 ppm. and 166–300 ppm. respectively in the soil of Site-I whereas 0.2–3.25 ppm.,

48–132 ppm., 17–41 ppm. and 10–42 ppm. respectively in the soil of Site-II (Tables 1 and 2). In the tissue of earthworm species, 10–25 ppm., 670–1045 ppm., 150–292 ppm., 60–200 ppm. of cadmium, zinc, lead and copper respectively was present at Site-I whereas in the same species when collected from Site-II it was 3–10 ppm., 66–122 ppm., 10–28 ppm. and 10–29 ppm. respectively (Tables 1 and 2).

It was observed that the accumulation of cadmium and zinc in the whole earthworm tissue of studied species were in higher level in comparison to the surrounding soil from the studied sites whereas a reverse results were found in case of the accumulation of heavy metals like copper and lead (Figs. 1-8)

Bioconcentration (E / S) factor of cadmium was 3–10 in polluted soil whereas in forest soil it was 2.16–15. Bioconcentration factor of zinc was 1.1–1.39 and 1.08–1.69, for lead it was 0.44–0.73 and 0.3–0.88, for copper it was 0.28–1.61 and 0.62–0.93 in polluted soil and in forest soil respectively. Only two examples for copper in forest soil was found where bioconcentration factor was one or more (Tables 1 and 2).

The level of concentration of heavy metals in soil and its accumulation in earthworm tissue varies from one month to another and as well as with in the studied year. In Site-I highest concentration of cadmium in soil was found in Sept. ’02, Feb. ’03 and in earthworm tissue accumulation of this metal was highest in Jan. ’02, Dec. ’02, March ’03; highest concentration of zinc was found in March ’03 in both soil and in earthworm tissue; for lead concentration in soil was high in Jan. ’03 and in earthworm tissue it was in March ’03; highest copper concentration in soil was found in Jan. ’02, Dec. ’02 and in earthworm tissue it was in Oct. ’01 (Table-1).

In Site-II highest concentration of cadmium in soil was found in May ’02 but in earthworm tissue accumulation of this metal was high in Jan. ’03; highest concentration of zinc in soil was found in May ’03, but for earthworm tissue it was in June ’03, lead concentration in soil was high in March ’03, but for earthworm tissue it was high in Nov. and Dec. ’01; copper concentration in soil was high in May ’03 and for earthworm tissue it was in July ’02 (Table-2).

From figures 9-12 it has been found that the level of heavy metal accumulation in the earthworm tissue is directly proportional to the amount of heavy metals in soil.

Organic carbon, p^H and electrical conductivity the soil of site-I and II is given in Table 4.

STATISTICAL TREATMENT OF DATA

Data pertaining to the level of heavy metals in the soil and in earthworm tissue were subjected to statistical analysis. The application of linear correlation was undertaken in the present study involving the data of soil factors, heavy metal content of soil and of earthworm tissue for each site. Analysis was carried out by pulling together data for 24 months (as species not found in February ’03) in Site-I (DP) and for 18 months (as species not found in January, April, May, ’02 & February–May, ’03) in Site-II (BRF).

LINEAR CORRELATION

From this analysis (Tables 3a and 3b), it is found that level of accumulation of Cd, Zn, Pb and Cu of earthworm tissue showed significant positive correlations with the level in soil of Site-II (BRF) but in Site-I (DP), level of accumulation of only Zn and Pb of earthworm tissue shows significant positive correlations with that of the level of Zn and Pb in soil.

In site-I (DP) significant negative correlations found between level of soil organic carbon and level of zinc and lead in soil; but in Site-II only lead content of soil shows significant negative correlations with soil organic carbon.

DISCUSSION

It is evident from the present study that heavy metal contents of soil and in earthworm tissue were much higher in Municipal wastes disposal site than that of the Reserve forest (Figs. 1-8). There was a seasonal variation in the level of concentration of heavy metals in the soil as well as its accumulation in earthworm tissue (Tables 1 and 2). Higher accumulation of heavy metals in the tissue of earthworm was found mainly in the dry season *i.e.*, in winter and summer; it may be due to the lower activity of earthworm at that time. Ireland (1975a) and Anderson (1979) was made similar observation regarding the variation of accumulation of heavy metals in earthworm tissue as well as in the soil. The absorption level of cadmium and zinc were maximum in earthworm than the soil in both studied area, on the other hand copper and lead concentration in earthworm tissues were low than the concentration of these heavy metals in surrounding soil (Figs. 9-12). This might be due to an active regulation of Cu and Pb in the body of earthworm but not of Cd and Zn. This observation coincide with the findings of Carter *et al.* (1980) in *Lumbricus rubellus* and *Allolobophora chlorotica*, Pietz *et al.* (1984), Beyer *et al.* (1987) in *A. tuberculata*, Morgan *et al.* (1986) in *L rubellus.*

The present study reveals that this species has the capability to withstand toxicity concentration of Cd, Zn, Pb, and Cu upto 6.25 ppm, upto 750 ppm, upto 410 ppm and upto 300 ppm respectively in the soil. Moreover this species might have capable to increase absorption rate of Cd in its body from as low as 3 ppm to 25 ppm, Zn from 66 to 1045 ppm, Pb from 10 to 292 ppm and Cu from 10 to 200 ppm (Tables 1 and 2). But bioconcentration factor tends to fall for each metal in polluted site (Site-I) than least polluted environment (Site-II). Edwards and Bohlen (1996), after reviewing several literatures, opined that the bioconcentration factor for many heavy metals in earthworms tends to fall as soil concentrations rise.

Accumulation level of Cd, Zn, Pb and Cu in this species shows a significant positive correlation with that of the concentration of these metal in soil in least polluted forest site, but accumulation level of only Zn and Pb of earthworm tissue shows significant positive correlation with that of the

concentration of these metals in polluted soil in wastes disposal site. Zietek and Pytasz (1979) also found a high correlation between concentrations in earthworm tissues and soils for both Zn and Pb. Mariño *et al.* (1998) showed significant interactions of Cu and Cd ions on *Lumbricus rubellus.* It suggests that when soil Cd and Cu content is in the higher level, then accumulation of Cd and Cu in tissue either influenced by other factors or may be the leveling off of these metals in earthworm tissue. Carter *et al.* (1980) opined that the leveling off of Cd levels in earthworm tissue without a concomitant increase in faecal levels might have been due to the high Cd levels in the soil having toxic effects. Ireland and Wooton (1976) found that Zn levels in tissue were not related to soil Zn levels where soil levels were high, on the contrary in this work concentration of Zn in tissue of this species shows significant positive correlation with the amount of Zn in soil in both these sites and bioconcentration factor of Zn is more than one in both cases.

The order of concentration factors of Cd, Zn, Pb and Cu in this species was Cd > Zn > Cu ≥ Pb. Ma (1982) was made similar observations in populations of *Aporrectodea caliginosa.* Significant negative correlations existed between concentration factors and soil organic matter content for Cu only (Ma, 1982), but Van Rhee (1975) showed positive correlations between the copper and organic matter content. Present study indicates that soil organic carbon has significant negative correlations with zinc and lead content of soil in polluted site. Regarding the question of high densities of this species in such environments, where there is a great deal of heavy metals, it might be due to the sub-lethal effects of these heavy metal poisoning. The toxic effects of heavy metals are partly determined by soil p^H and the content of organic matter, high values being protective (Peredney and Williams, 2000). Perhaps also others factors, not investigated here, had a protective effects on earthworm viability as, for example, bioavailibity of Zn, Pb and Cd is limited in the presence of phosphorus compounds (Maenpaa *et al.* 2002).

From the foregoing discussion it is seen that the uptake pattern of heavy metals in earthworms are a complicated matter. There are differences in rates of uptake attributed to soil p^H, to interactions in the environment and in the earthworms' internal chemistry between various combinations and relative concentrations of heavy metals that occur together, to the chemical form in which the heavy metals occur, to adsorption of heavy metals onto surfaces of clay or organic matter particles and to selection of food by the earthworms (Lee, 1985). Helmke *et al.* (1979), Morgan (1986), Beyer *et al.* (1987) stressed the value of using earthworms to assess heavy metal contamination. This study indicates that analysis of tissue of this earthworm species could be proved to be a useful for lowering down the heavy metal pollution at any particular site.

With respect to the question of earthworms being a source of contamination for other animals it seems clear that earthworms are preyed on by various birds, amphibians, reptiles and mammals living near municipal waste disposal site will be subjected to ingestion of considerable amount of Cd, Zn and some amount of Pb and Cu from this species. The studies on this aspect are also in progress.

Table 1. : Showing amount of heavy metals in soil and in whole tissue (per gm. dry wt.) of *L. mauritii* collected from Dhapa (Municipal wastes disposal site of Kolkata).

Month	Cd (ppm)			Zn (ppm)			Pb (ppm)			Cu (ppm)		
	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S
June '01	4	12	3	550	670	1.21	280	190	0.67	201	90	0.44
July '01	3	12	4	580	700	1.2	270	155	0.57	220	102	0.46
Aug '01	3	16	5.33	600	810	1.35	290	160	0.55	220	95	0.43
Sept '01	3	16	5.33	600	720	1.2	301	170	0.56	170	88	0.51
Oct '01	2.75	10	3.63	630	700	1.11	345	205	0.59	265	200	0.75
Nov '01	2.5	10	4	650	790	1.21	320	186	0.58	250	190	0.76
Dec '01	2.5	23	9.2	650	800	1.23	360	201	0.55	270	170	0.62
Jan '02	2.75	25	9.09	670	835	1.24	390	190	0.48	300	163	0.54
April '02	5	15	3	650	830	1.27	320	170	0.53	250	125	0.5
May '02	6	18	3	650	842	1.29	320	163	0.5	210	140	0.66
June '02	5	23	4.6	610	801	1.31	260	177	0.68	230	79	0.34
July '02	4	14	3.5	610	780	1.27	260	165	0.63	210	160	0.76
Aug '02	4	13	3.25	580	750	1.29	300	170	0.56	190	150	0.78
Sept '02	6.25	20	3.2	650	864	1.32	330	164	0.49	250	147	0.58
Oct '02	3	23	7.66	660	755	1.14	316	164	0.51	204	197	0.96
Nov '02	3	14	4.66	630	825	1.3	380	275	0.72	190	173	0.91
Dec '02	2.5	25	10	690	780	1.13	350	180	0.51	300	150	0.5
Jan '03	3	20	6.66	650	755	1.16	410	290	0.7	220	172	0.78
Feb '03	6.25	n.f.		680	n.f.		380	n.f.		200	n.f.	
Mar '03	5.5	25	4.5	750	1045	1.39	400	292	0.73	166	125	0.75
April '03	4	18	4.5	630	720	1.14	340	150	0.44	220	166	0.75
May '03	5	18	3.6	650	720	1.1	322	160	0.49	195	142	0.72
June '03	5	20	4	570	680	1.19	285	162	0.56	210	60	0.28
July '03	3	14	4.66	580	680	1.17	250	176	0.7	200	130	0.65
Aug '03	3	14	4.66	600	755	1.25	270	185	0.68	170	130	0.76

*n.f. = Specie not found

Table 2. : Showing amount of heavy metals in soil and in whole tissue (per gm. dry wt.) of *L. mauritii* collected from Bethuadahari Reserve Forest, Nadia.

Month	Cd (ppm)			Zn (ppm)			Pb (ppm)			Cu (ppm)		
	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S	Soil	Earth-worm	E/S
June '01	2	9	4.5	94	102	1.08	34	20	0.58	35	28	0.8
July '01	0.76	4	5.26	80	100	1.25	22	15	0.68	20	16	0.8
Aug '01	1	7	7	70	88	1.25	20	16	0.8	16	14	0.87
Sept '01	1	6	6	70	94	1.34	28	22	0.78	22	20	0.9
Oct '01	1	4	4	65	82	1.26	26	18	0.69	25	20	0.8
Nov '01	2	8	4	60	88	1.46	32	28	0.87	32	22	0.68
Doc '01	2	9	4.5	94	114	1.21	36	28	0.77	32	22	0.68
Jan '02	2.75	n.f.		80	n.f.		30	n.f.		35	n.f.	
April '02	3	n.f.		90	n.f.		30	n.f.		40	n.f.	
May '02	3.25	n.f.		100	n.f.		30	n.f.		40	n.f.	
June '02	1.55	4.5	2.9	65	94	1.44	32	25	0.78	22	16	0.72
July '02	0.2	3	15	56	95	1.69	18	15	0.83	18	29	1.61
Aug '02	0.5	6.5	13	63	90	1.42	25	18	0.72	26	26	1
Sept '02	0.7	5.5	7.85	65	83	1.27	33	10	0.3	21	19	0.9
Oct '02	1.25	4	3.2	60	80	1.33	25	20	0.8	20	18	0.9
Nov '02	1.5	3.25	2.16	70	90	1.28	25	22	0.88	24	19	0.79
Dec '02	2	6	3	75	93	1.24	30	22	0.73	30	26	0.86
Jan '03	3	10	3.33	86	100	1.16	30	20	0.66	30	28	0.93
Feb '03	3	n.f.		90	n.f.		36	n.f.		38	n.f.	
Mar '03	2.88	n.f.		100	n.f.		41	n.f.		40	n.f.	
Agril '03	2.5	n.f.		120	n.f.		32	n.f.		40	n.f.	
May '03	3	n.f.		132	n.f.		38	n.f.		42	n.f.	
June '03	2.6	8	3.07	105	122	1.16	30	24	0.8	38	28	0.73
July '03	0.5	7	14	48	70	1.45	26	18	0.69	14	10	0.71
Aug '03	0.8	7	8.75	50	66	1.32	22	15	0.68	16	10	0.62

*n.f. = Species not found

Table 3. : Showing correlations between different variables in the different sampling sites.

Table 3a : Site–I / DP

	Cd-Soil	Cd-Tis	Ratio 1	Zn-Soil	Zn-Tis	Ratio 2	Pb-Soil	Pb-Tis	Ratio 3			
Cd-Soil	1.000											
Cd-Tis	0.200	1.000										
Ratio 1	–0.580**	0.658**	1.000									
Zn-Soil	0.133	0.610**	0.403	1.000								
Zn-Tis	0.377	0.478*	0.095	0.770**	1.000							
Ratio 2	0.419*	0.105	–0.246	0.127	0.728**	1.000						
Pb-Soil	–0.083	0.450*	0.440*	0.748**	0.515**	0.000	1.000					
Pb-Tis	–0.121	0.174	0.170	0.450*	0.465*	0.222	0.695**	1.000				
Ratio 3	–0.116	–0.204	–0.174	–0.134	0.115	0.298	–0.061	0.669**	1.000			
	Cd-Soil	**Cd-Tis**	**Ratio 1**	**Zn-Soil**	**Zn-Tis**	**Ratio 2**	**Pb-Soil**	**Pb-Tis**	**Ratio 3**	**Cu-Soil**	**Cu-Tis**	**Ratio 4**
Cu-Soil	–0.249	0.276	0.511*	0.288	0.034	–0.221	0.304	–0.147	–0.462*	1.000		
Cu-Tis	–0.356	–0.030	0.280	0.473*	0.126	–0.299	0.524**	0.256	–0.164	0.334	1.000	
Ratio 4	–0.206	–0.145	0.015	0.352	0.162	–0.132	0.370	0.376	0.130	–0.263	0.814**	1.000
p^H-Soil	0.105	–0.278	–0.248	–0.296	–0.229	–0.011	–0.301	–0.441*	–0.320	0.116	–0.143	–0.228
EC	–0.191	0.155	0.237	0.367	0.239	–0.013	0.460*	0.370	0.020	–0.131	0.397	0.493*
OC	0.135	–0.247	–0.304	–0.470*	–0.173	0.220	–0.406*	–0.078	0.292	–0.259	–0.508*	–0.377
	p^H-Soil	**EC**	**OC**									
p^H-Soil	1.000											
EC	–0.659**	1.000										
OC	–0.124	0.055	1.000									

Table 3. : *(Contd.).*

Table 3b : Site–II / BRF

	Cd-Soil	Cd-Tis	Ratio 1	Zn-Soil	Zn-Tis	Ratio 2	Pb-Soil	Pb-Tis	Ratio 3	Cu-Soil	Cu-Tis	Ratio 4
Cd-Soil	1.000											
Cd-Tis	0.620**	1.000										
Ratio 1	–0.738**	–0.115	1.000									
Zn-Soil	0.721**	0.484*	–0.547*	1.000								
Zn-Tis	0.597**	0.315	–0.383	0.900**	1.000							
Ratio 2	–0.610**	–0.492*	0.643**	–0.738**	–0.381	1.000						
Pb-Soil	0.634**	0.542*	–0.493*	0.504*	0.410	–0.449	1.000					
Pb-Tis	0.650**	0.340	–0.528*	0.379	0.476*	–0.095	0.553*	1.000				
Ratio 3	0.146	–0.154	–0.142	–0.033	0.180	0.332	–0.306	0.617**	1.000			
Cu-Soil	0.806**	0.537*	–0.540*	0.783**	0.737**	–0.517*	0.692**	0.620**	0.063	1.000		
Cu-Tis	0.473*	0.235	–0.124	0.564*	0.674**	–0.129	0.296	0.253	0.050	0.740**	1.000	
Ratio 4	–0.376	–0.394	0.520*	–0.189	0.069	0.542*	–0.475*	–0.388	0.061	–0.220	0.480*	1.000
p^H-Soil	–0.034	–0.090	0.169	0.079	0.117	0.079	–0.248	–0.030	0.216	–0.015	–0.037	–0.006
EC	0.397	0.135	–0.331	0.336	0.382	–0.110	0.286	0.354	0.168	0.401	0.313	–0.060
OC	–0.415	–0.266	0.534*	–0.354	–0.208	0.492*	–0.545*	–0.205	0.278	–0.406	–0.249	0.182

	p^H-Soil	EC	OC
p^H-Soil	1.000		
EC	0.334	1.000	
OC	0.749**	0.103	1.000

**Significant at 1% level, *Significant at 5% level.

Table 4. : Showing organic carbon, electrical conductivity and p^H of soil collected from Site–I and Site–II.

	Site–I			Site–II		
Month	**P^H**	**EC (dSm^{-1})**	**OC (%)**	**P^H**	**EC (dSm^{-1})**	**OC (%)**
June '01	7.1	0.25	3.66	7.5	0.52	2.27
July '01	7.2	0.36	3.54	7.2	0.18	2.54
Aug '01	7.3	0.63	3.86	7.1	0.31	2.42
Sept '01	7.1	0.56	3.33	6.3	0.23	2.1
Oct '01	7.08	0.76	3.46	6.5	0.21	1.93
Nov '01	7.15	0.36	2.69	6.7	0.33	2.16
Dec '01	7.2	0.33	3.02	6.83	0.1	2.07
Jan '02	6.86	0.84	3.29	6.7	0.3	1.78
Apr '02	7.22	0.3	2.96	7.3	0.14	1.46
May '02	7.16	0.59	3.23	6.8	0.33	2.01
June '02	7.15	0.22	2.94	7.5	0.59	2.8
July '02	7.24	0.31	3.86	7.5	0.22	3
Aug '02	7.3	0.67	3.73	7.2	0.29	2.95
Sept '02	7.15	0.35	3.5	6.62	0.15	2.08
Oct '02	6.9	0.9	2.33	6.5	0.2	2.54
Nov '02	7.2	0.42	2.55	7.9	0.28	2.71
Dec '02	7.3	0.29	2.86	6.9	0.16	2.01
Jan '03	6.94	0.91	3.46	6.7	0.3	2.1
Feb '03	6.5	1.5	3.39	6.9	0.22	1.85
Mar '03	6.93	0.73	3.38	7.3	0.19	2.3
Apr '03	7.38	0.19	2.21	7.5	0.14	0.74
May '03	7.2	0.62	3.23	7.2	0.21	1.51
June '03	7.16	0.18	4.23	7.7	0.4	2.82
July '03	7.16	0.23	3.68	7.3	0.13	2.91
Aug '03	6.9	0.7	4.1	7.63	0.1	3.07

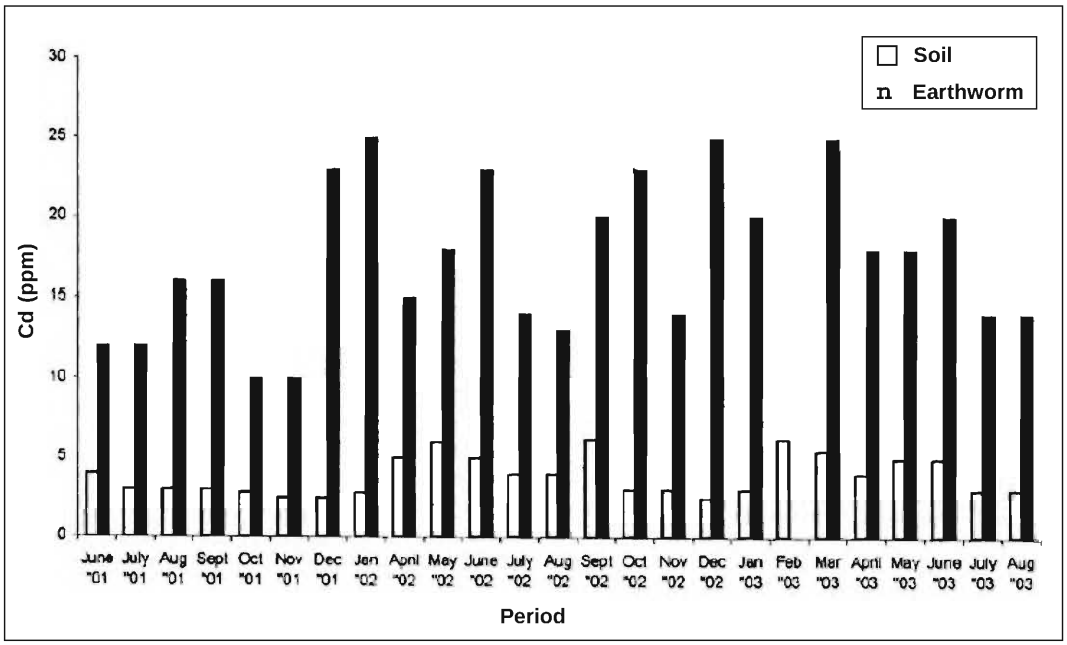

Fig. 1. : Showing amount of cadmium in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Dhapa (Municipal wastes disposal site of Kolkata).

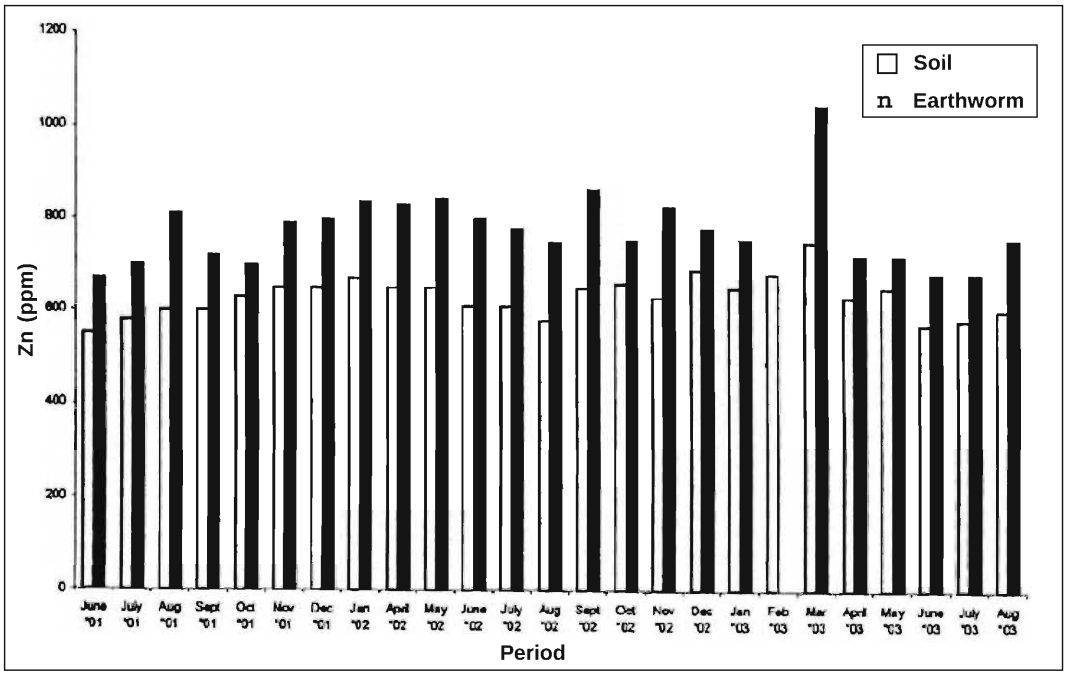

Fig. 2. : Showing amount of zinc in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Dhapa (Municipal wastes disposal site of Kolkata).

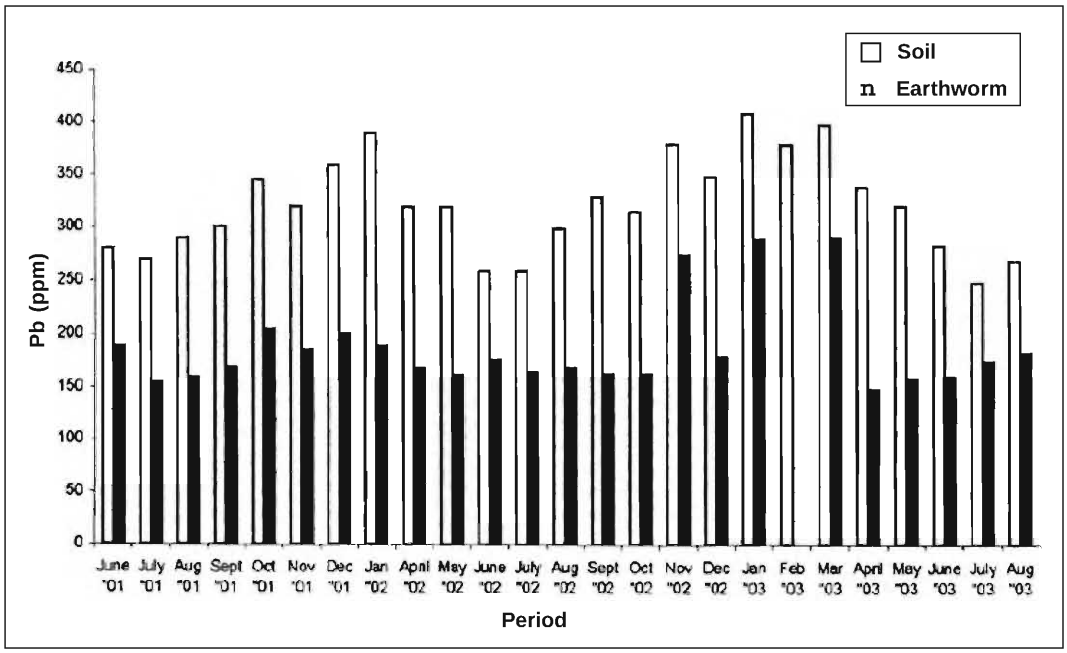

Fig. 3. : Showing amount of lead in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Dhapa (Municipal wastes disposal site of Kolkata).

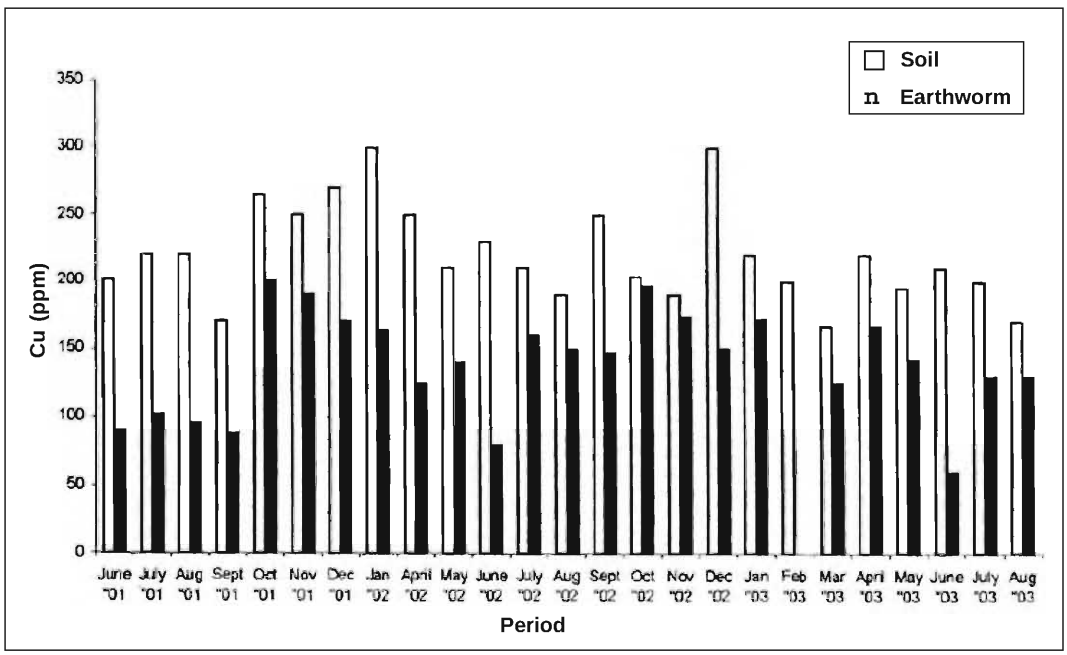

Fig. 4. : Showing amount of copper in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Dhapa (Municipal wastes disposal site of Kolkata).

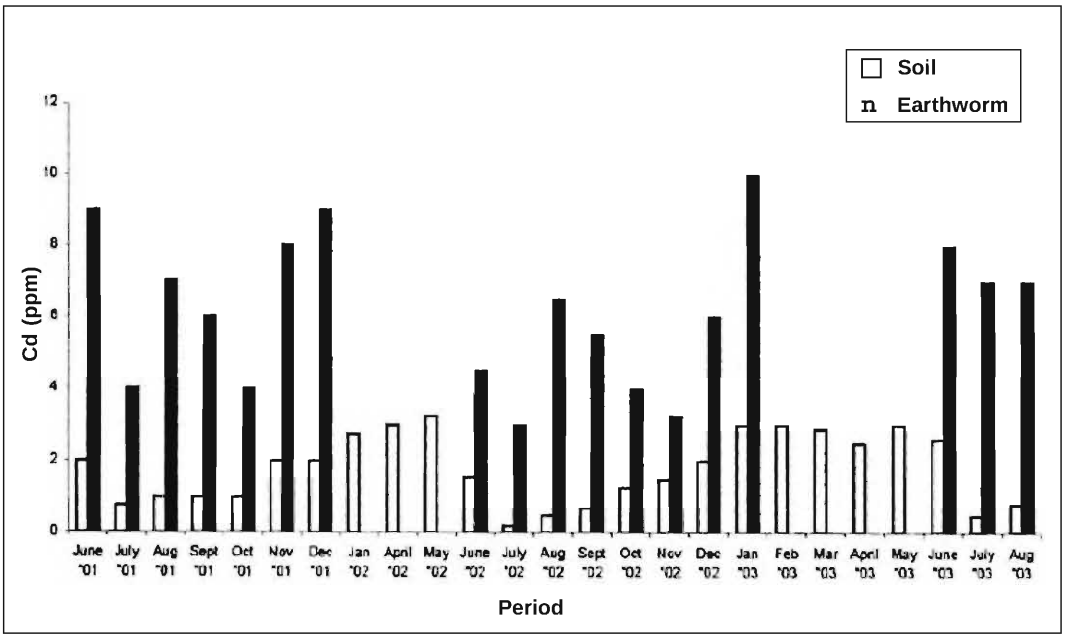

Fig. 5. : Showing amount of cadmium in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Bethuadahari Reserve Forest, Nadia

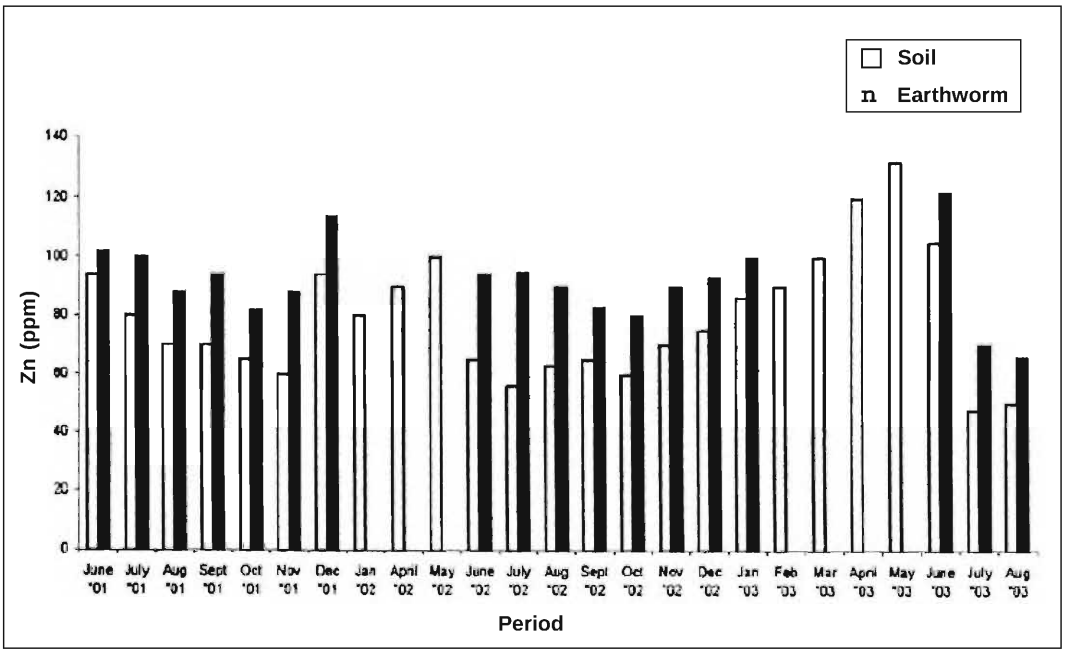

Fig. 6. : Showing amount of zinc in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Bethuadahari Reserve Forest, Nadia

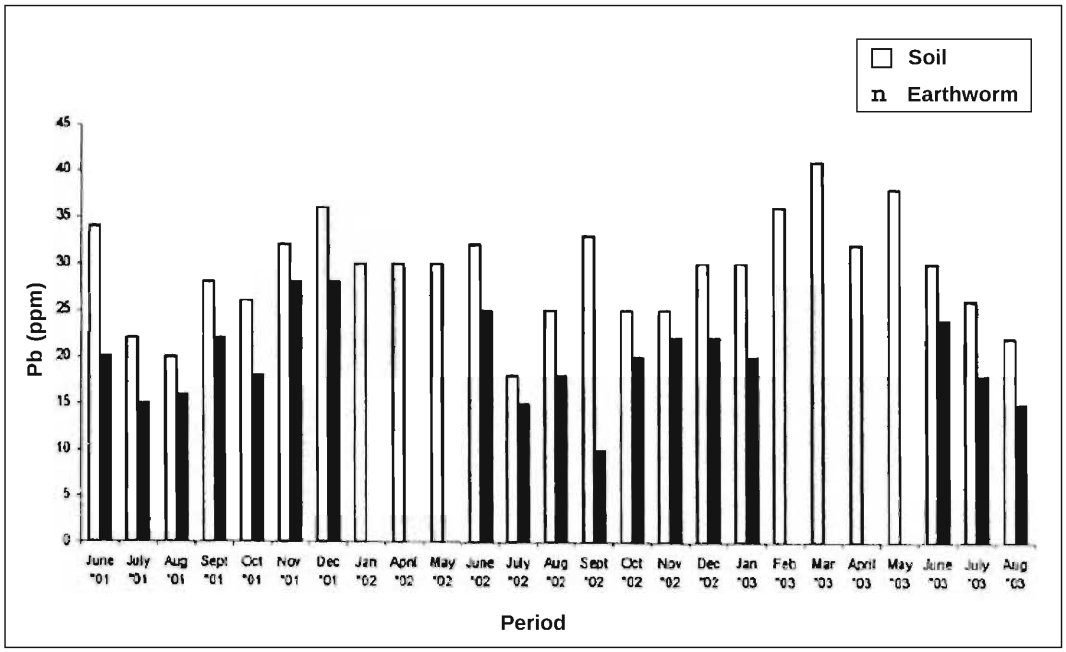

Fig. 7. : Showing amount of lead in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Bethuadahari Reserve Forest, Nadia

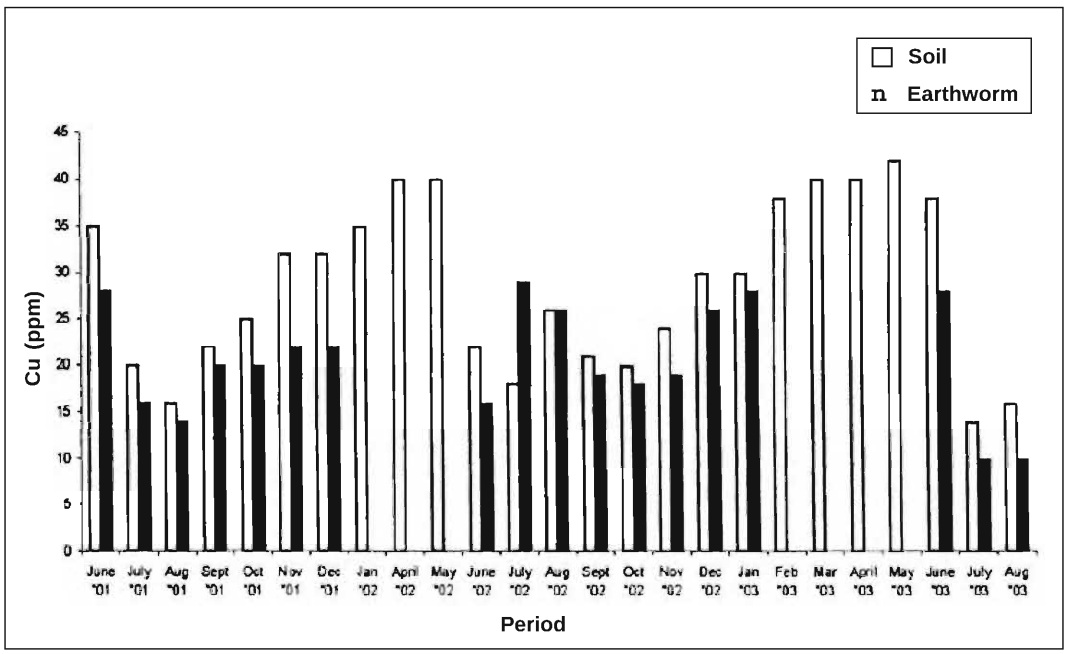

Fig. 8. : Showing amount of copper in per gm. soil and whole tissue (per gm. dry wt.) of *L. mauritii* collected from Bethuadahari Reserve Forest, Nadia

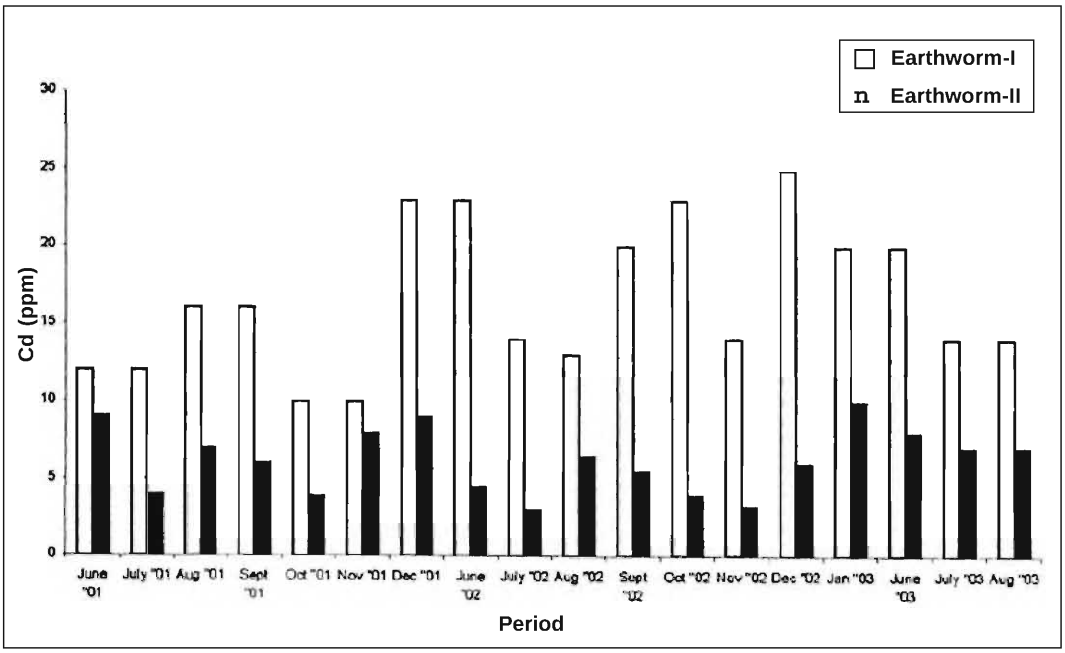

Fig. 9. : Showing comparison between the levels of cadmium of whole tissue (per gm. dry wt.) of *L. mauritii* collected from site–I and site–II.

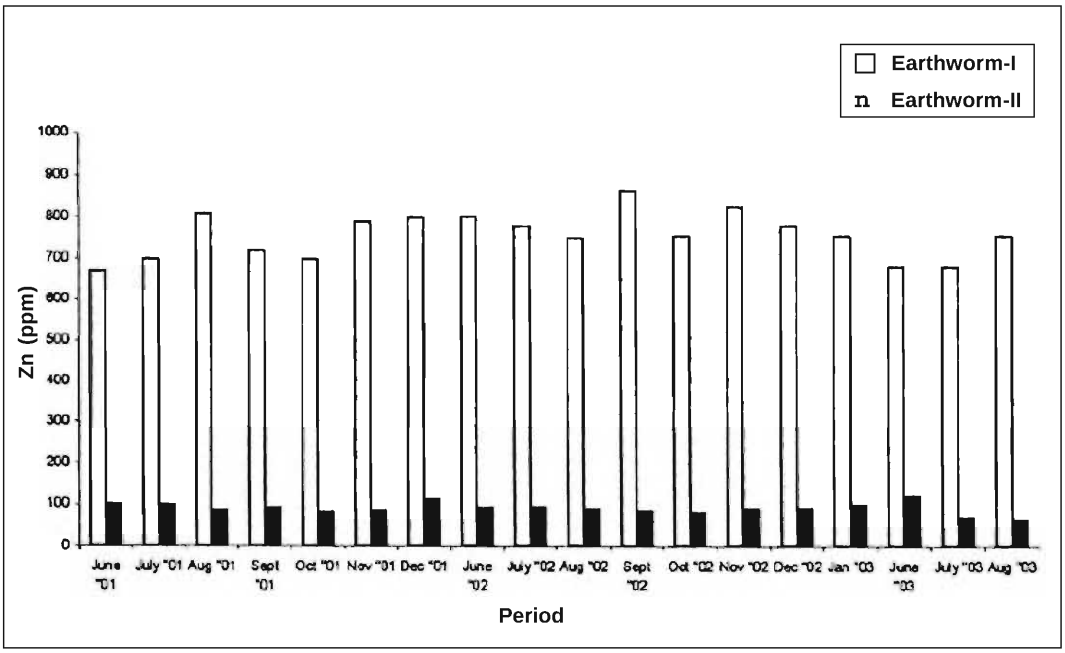

Fig. 10. : Showing comparison between the levels of zinc of whole tissue (per gm. dry wt.) of *L. mauritii* collected from site–I and site–II.

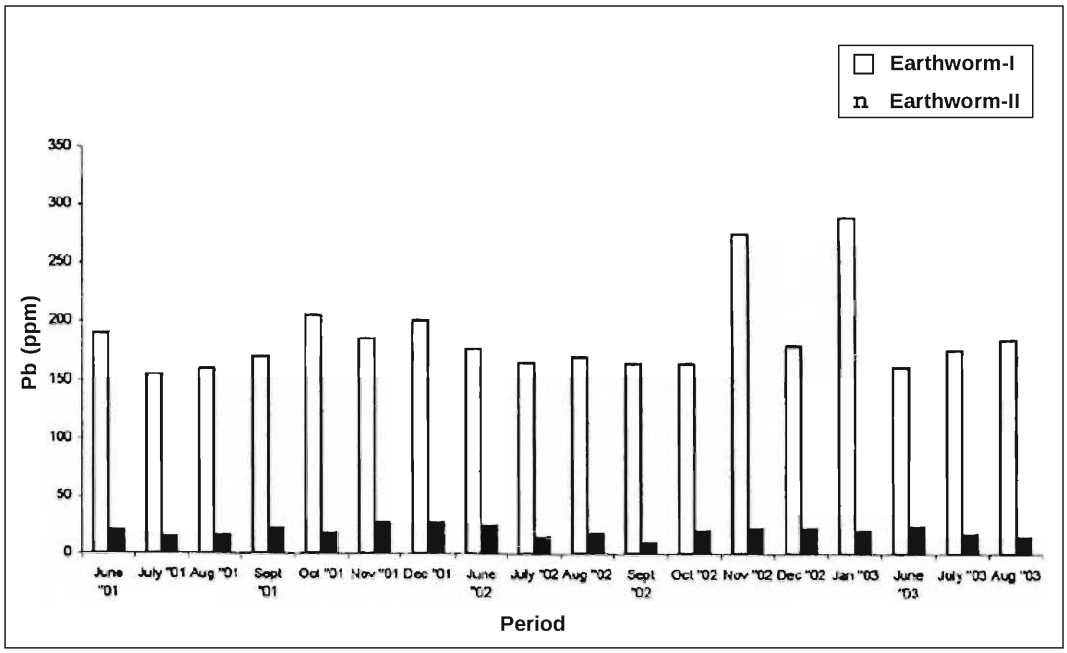

Fig. 11. : Showing comparison between the levels of zinc of whole tissue (per gm. dry wt.) of *L. mauritii* collected from site–I and site–II.

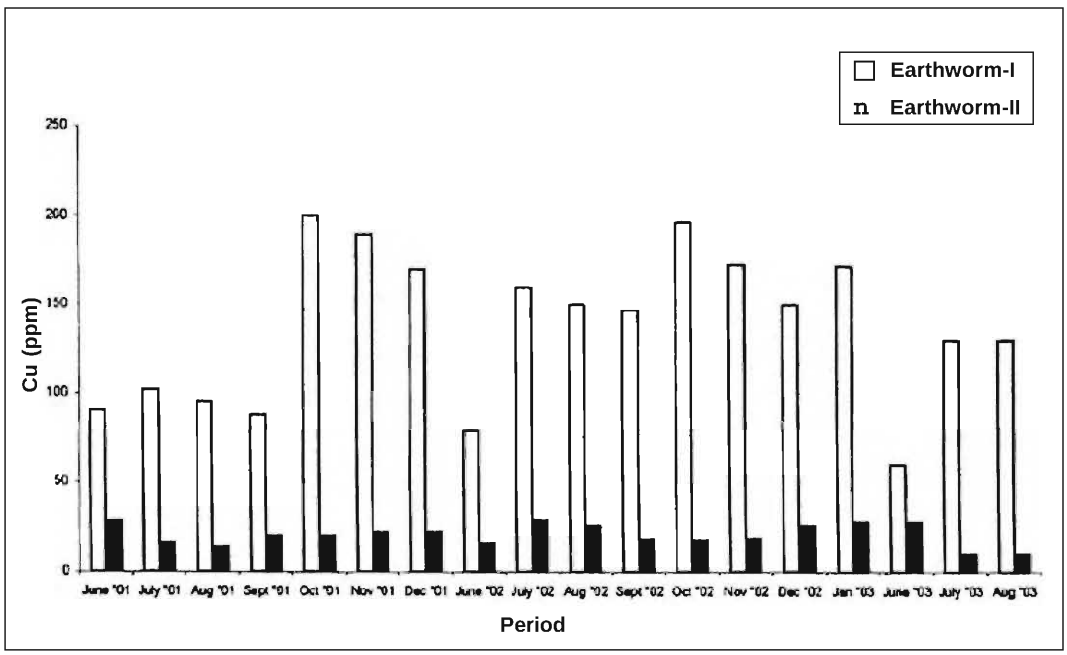

Fig. 12. : Showing comparison between the levels of copper of whole tissue (per gm. dry wt.) of *L. mauritii* collected from site–I and site–II.

SUMMARY

Study has been conducted during the period from June, 2001 to August, 2003 (total 25 months) to know the level of accumulation of some heavy metals in the tissue of *L. mauritii* (Annelida : Oligochaeta) collected from the municipal wastes disposal site of Kolkata, as well as from a reserve forest floor and to determine whether this dominant species could be use as a tool for the absorption of heavy metal in a contaminated soil. Metal content was estimated from whole earthworm tissue and in the surrounding soil (per gm. dry weight). Besides soil features like organic carbon, p^H and electrical conductivity were also analyzed. The concentration levels of studied metals were varied from the earthworm tissue and the surrounding soil in both the sites, as well as from one month to another. Accumulation of some heavy metals in earthworm tissue was in higher level in comparison to surrounding soil Detail analyses on all these aspects have been discussed. The earthworms being a very good source of food for other vertebrates, therefore the study on the effect of consumption of this contaminated species by those animals are also in progress.

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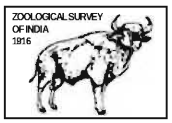

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MORPHOMETRIC STUDY OF THE MUD EEL *MONOPTERUS CUCHIA* (HAM.) FROM THE NEW ALLUVIAL ZONE OF WEST BENGAL

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INTRODUCTION

Monopterus cuchia, commonly known as Gangetic mud eel, is a fish with snake like appearance and smooth slimy skin. The eel belongs to the family Synbranchidae and order Synbranchiformes. It is an indigenous fish species of the New Alluvial Zone of West Bengal, locally known as 'Cuche'. The natural habitat of the fish is rivers, ponds, beels and other freshwater bodies. The eel is rich in protein, iron and vitamin content and quite relished as a food fish by the economically backward people and tribals of West Bengal. The fish population has dwindled to a considerable extent in the New Alluvial Zone of West Bengal due to urbanisation, intensive agriculture and above all population explosion. This fish has been determined to be an endangered fish (Das and De, 2002).

Though the biological study of other food fishes like Indian Major Carps have been done by several workers, the study on *M. cuchia* is very few. No work has been done from West Bengal. Thus, the present study was undertaken to study the biology of *Monopterus cuchia* from the New Alluvial Zone of West Bengal and this paper deals with the morphometry of *M. cuchia* from the New Alluvial Zone of West Bengal. This kind of study is very much essential for solving the race problem, Zupanovic (1968) stated "As it is essential to distinguish between different species, so it is essential to distinguish between the self perpetuating sub-groups within the species. These subgroups may be equivalent to what taxonomists call sub-species, but they may be equivalent to what taxonomists call sub-species, but they may be generally of lesser rank, in the fishery literature, they are often called races or populations."

MATERIALS AND METHODS

The material for the present study pertains to the specimens of *Monopterus cuchia* collected from various beels of the New Alluvial Zone of West Bengal (21.5–24.5° North Latitude and

86–89° East Longitude) during the period February 2005 through January 2006. Specimens were collected every month and immediately after collection specimens were fixed in 10% formalin and brought to the laboratory for detailed measurements. The study is based on the examination of 62 specimens in the size range of 15.0 to 80.5 cm. A total of 12 morphometric parameters (Fig. 1) have been taken up for study according to the methods described by Lowe-McConnel (1976). Divider and measuring board, having graduations in centimeter have been used for various measurements. All linear measurements were made to nearest centimeter.

The number of times each morphometric character went into reference length of the fish was considered as Biometric Index (Tobor, 1974). For each character, a mean biometric index for each 10 cm length group has been calculated.

The regression of various morphometric characters on total length was obtained by least square method with the formula :

$$Y = a + bx$$

where '*Y*' is the variable character such as head length, body depth etc., '*a*' is the constant value to be determined, '*b*' is the regression co-efficient and '*x*' is the total length. The correlation co-efficient '*r*' of these regressions was computed.

RESULTS AND DISCUSSION

The mean and range of various morphometric characters of *M. cuchia* has been presented in Table 1. The morphometric characters showed a positive increase with increase in length of the fish. The regression equation of different variable characters (*Y*) on total length/head length (*X*) has been presented in Table 2. The regression co-efficient '*b*' of different variable characters indicates that the rate of growth in respect to total length is highest in case of head width and lowest in case of pre-orbital length in relation to head length. High values of correlation co-efficient '*r*' (Table 2) obtained indicates a high degree of positive correlation between the different morphometric parameters with the reference length (Total length/Head length). Biometric index of *M. cuchia* (Fig. 2) studied indicates that the indices of length of caudal peduncle, gapa of mouth, and inter-orbital length were almost constant. According to Bayagbona (1963), a constant index in any of the biometric characters in relation to its reference length is isometric. The indices of the growth of head depth and body depth in relation to total length and upper jaw length in relation to head length was found to be allometric.

The mean and range of different morphometric characters of males and females of *M. cuchia* has been presented in Table 3. Considerable difference in the morphometric characters has been observed between males and females in their head regions. The males were found to have greater pre-orbital length. On the other hand the females had greater gape of mouth. According to

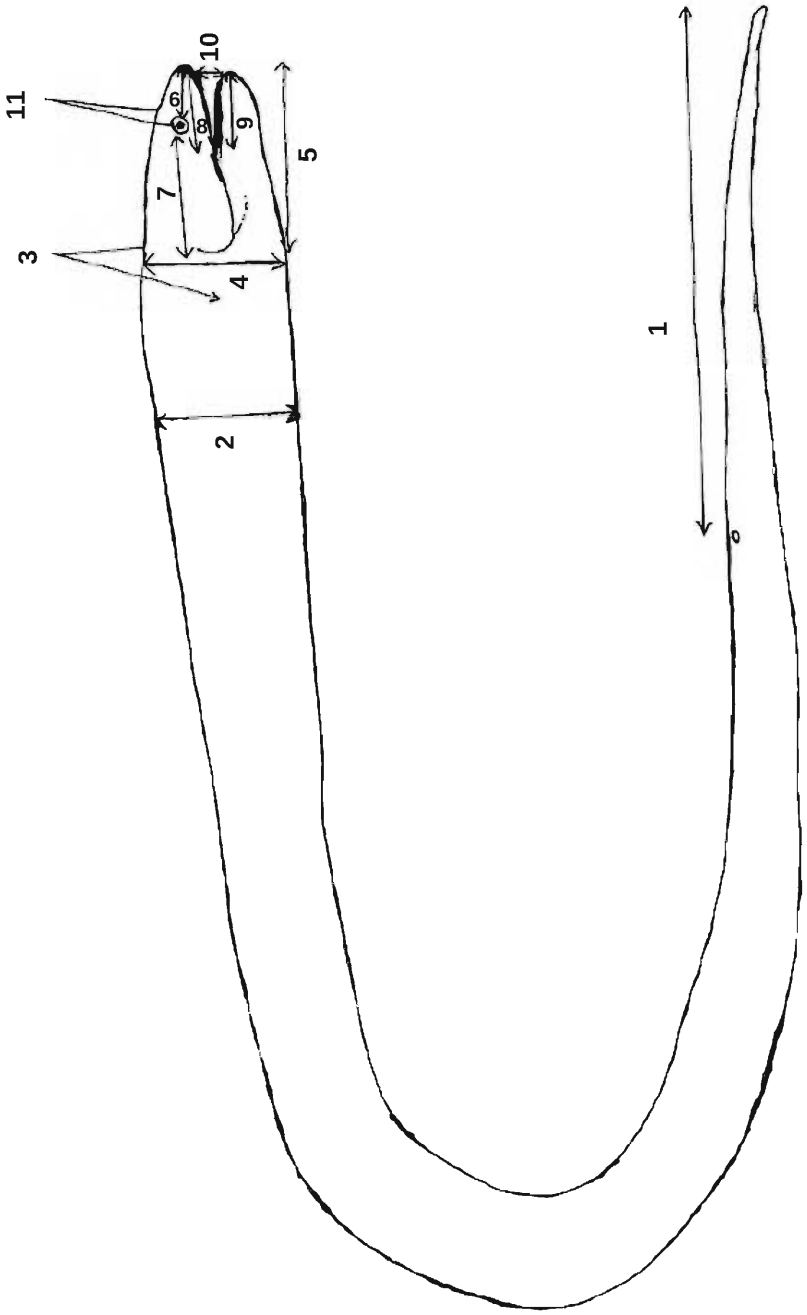

Fig. 1. : Diagramatic representation of the morphometric parameters of *Monopterus cuchia*.
1. Length of caudal peduncle (LCP); 2. Body depth (BD); 3. Head width (HW); 4. Head depth (HD); 5. Head length (HL); 6. Pre-orbital length (Pre-OL); 7. Post-orbital length (Post-OL); 8. Upper jaw length (UJL); 9. Lower jaw length (LJL); 10. Gape of mouth (GOM); 11. Inter orbital length (IOL).

Table 1. : Morphometric analysis of *Monopterus cuchia* from the New Alluvial Zone of West Bengal (Jungle beel).

Sl. No.	Parameters	Mean (mm)	Range (mm)
1.	Total length (TL)	452.7	150–805
2.	Length of caudal peduncle (LCP)	116	43–200
3.	Head length (HL)	34.8	9–55
4.	Pre-orbital length (POL)	7.6	3–14
5.	Post-orbital length (POL)	20.6	6–42
6.	Head depth (HD)	17	5–36
7.	Body depth (BD)	20.8	7–45
8.	Upper jaw length (UJL)	15.2	5–28
9.	Lower jaw length (LJL)	15.4	5–29
10.	Gape of mouth (GOM)	9.9	4–23
11.	Inter orbital depth (IOD)	7	3–13
12.	Head width (HW)	18.8	6–35

Table 2. : Regression equations of morphometric parameters of *Monopterus cuchia*.

Parameters	Regression equation	Correlation coefficient
Length of caudal peduncle (Y) on total length (X)	Y = 2.0600 + 0.2077 X	0.9927
Head length (Y) on total length (X)	Y = 0.1574 + 0.0637 X	0.9925
Head depth (Y) on total length (X)	Y = 0.1187 + 0.0349 X	0.9855
Body depth (Y) on total length (X)	Y = 0.1546 + 0.0424 X	0.9957
Length of upper jaw (Y) on total length (X)	Y = 0.2096 + 0.0300 X	0.9703
Length of lower jaw (Y) on total length (X)	Y = 0.2240 + 0.0289 X	0.9827
Head width (Y) on total length (X)	Y = 0.0910 + 0.0379 X	0.9976
Post orbital length (Y) on total length (X)	Y = 0.0210 + 0.0457 X	0.9897
Gape of mouth (Y) on head length (X)	Y = –0.2150 + 0.7297 X	0.9720
Pre orbital length (Y) on head length (X)	Y = 0.1458 + 0.3570 X	0.9310
Inter orbital length (Y) on head length (X)	Y = –0.0220 + 0.4140 X	0.9650

Table 3. : Morphometric analysis of *M. cuchia* (Male and Female).

Parameters	Male		Female	
	Mean	Range	Mean	Range
Total length (TL)	64.81	47–80.5	69.18	55–80.5
Length of caudal peduncle (LCP)	15.36	10.4–20	16.37	14.5–20
Head length (HL)	4.37	3.2–5.5	4.65	3.7–5.5
Pre-orbital length (POL)	1.02	0.8–1.4	1.01	0.9–1.3
Post-orbital length (POL)	3.0	2.2–3.8	3.31	2.5–4.2
Head depth (HD)	2.53	1.9–3.6	2.32	1.6–3.2
Body depth (BD)	3.03	2.5–4.5	2.97	2.2–4.2
Upper jaw length (UJL)	2.15	1.3–2.8	2.12	1.7–2.6
Lower jaw length (LJL)	2.15	1.4–2.9	2.02	1.6–2.5
Gape of mouth (GOM)	1.42	0.6–2.0	1.96	1.2–2.3
Inter orbital depth (IOD)	1.0	0.8–1.2	1.02	0.9–1.3
Head width (HW)	2.7	2.0–3.5	2.52	1.9–3.0

Gold (1966) ratios between morphological characters of fish will not necessarily be constant for the organisms of the same species due to variation resulting from differences in sex, race and nutrition and/or other environmental factors.

In the present study an attempt has been made to compare the morphometric characters between dark and white varieties of *M. cuchia.* Variations have been observed between various characters (Table 4). Percentage of length of caudal peduncle, head length, post-orbital length and body depth in relation to total length was found to be higher in white varieties. Such variations are also evident from the regression equations (Table 5). From the 'r' values of the different parameters it is clear that the different parameters in case of dark variety are more correlated with their reference length in comparison to the white variety.

The biometric indices (Table 6) shows that the growth of length of caudal peduncle in relation to total length is isometric in both varieties and the growth of inter-orbital length in relation to head length is isometric in both the varieties. The growth of gape of mouth in relation to head length is isometric in the dark variety and head length in relation to total length is isometric in the white variety. All the other characters are allometric in both the varieties.

Johal *et al.*, (1994) classified various morphometric characters on the basis of range difference into genetical (less than 10%), intermediate (10–15%) and environmentally (greater than 15%) controlled characters.

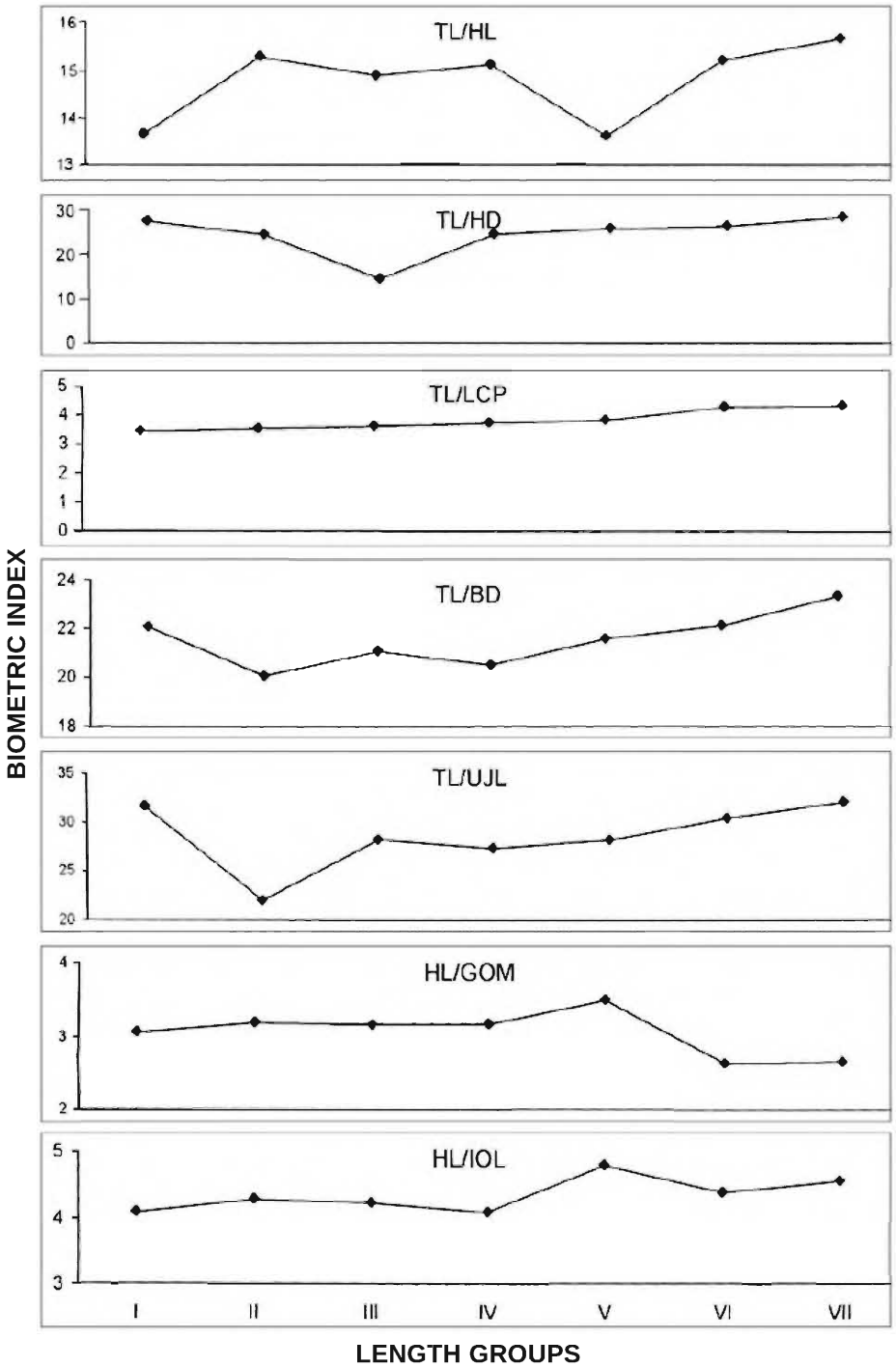

Fig. 2. : Biometric indices of *M. cuchia* at different length groups.

Table 4. : Morphometric analysis of *M. cuchia* (Black and White variety).

Parameters	Black variety		White variety	
	Mean	Range	Mean	Range
Total length (TL)	57.40	15–80.5	41.5	24.3–68.5
Length of caudal peduncle (LCP)	11.97	4.3–20	10.98	6.5–20
Head length (HL)	3.03	0.9–5.5	5.83	1.6–5.5
Pre-orbital length (POL)	0.78	0.3–1.3	0.7	0.4–1.4
Post-orbital length (POL)	2.12	0.6–4.2	1.9	1.0–3.8
Head depth (HD)	1.77	0.5–3.2	1.61	1.0–3.6
Body depth (BD)	2.15	0.7–4.2	1.95	1.2–4.5
Upper jaw length (UJL)	1.5	0.5–2.8	1.44	0.9–2.5
Lower jaw length (LJL)	1.53	0.5–2.9	1.46	0.9–2.7
Gape of mouth (GOM)	1.09	0.4–2.0	0.73	0.5–1.2
Inter orbital depth (IOD)	0.7	0.3–1.2	0.63	0.4–1.2
Head width (HW)	1.9	0.6–3.2	1.65	0.8–3.5

Table 5. : Regression equations of morphometric parameters of *M. cuchia* (Black and White variety).

Parameters	Regression equations	Correlation coefficient	Regression equations	Correlation coefficient
	Black variety		White variety	
Length of caudal peduncle (Y) on total length (X)	Y = 2.077 + 0.2069 X	0.9908	Y = 1.927 + 0.217 X	0.9922
Head length (Y) on total length (X)	Y = 0.068 + 0.065 X	0.9989	Y = 0.8517 + 0.046 X	0.6697
Head depth (Y) on total length (X)	Y = –0.038 + 0.039 X	0.9934	Y = 0.482 + 0.0298 X	0.6738
Body depth (Y) on total length (X)	Y = –0.016 + 0.047 X	0.9900	Y = 0.529 + 0.036 X	0.6910
Length of upper jaw (Y) on total length (X)	Y = –0.025 + 0.034 X	0.9895	Y = 0.749 + 0.020 X	0.5424
Length of lower jaw (Y) on total length (X)	Y = 0.0325 + 0.0328 X	0.9839	Y = 0.222 + 0.0318 X	0.9272
Head width (Y) on total length (X)	Y = –0.054 + 0.04 X	0.9931	Y = –0.186 + 0.045 X	0.9775

Table 5. : *(Cont'd.).*

Parameters	Regression equations	Correlation coefficient	Regression equations	Correlation coefficient
	Black variety		White variety	
Post orbital length (Y) on total length (X)	Y = –0.041 + 0.046 X	0.9949	Y = –0.187 + 0.049 X	0.8389
Gape of mouth (Y) on head length (X)	Y = –0.154 + 0.404 X	0.9207	Y = 0.417 + 0.122 X	0.8082
Pre orbital length (Y) on head length (X)	Y = 0.155 + 0.202 X	0.9830	Y = 0.042 + 0.242 X	0.9998
Inter orbital length (Y) on head length (X)	Y = 0.018 + 0.218 X	0.9653	Y = –0.089 + 0.199 X	0.9775

Table 6. : Biometric index of *M. cuchia* in different length groups (Black and White variety).

	Black variety							White variety				
	I	II	III	IV	V	VI	VII	II	III	IV	V	VI
TL/HL	13.6	15.24	14.86	15.18	14.23	15.28	15.02	15.58	15.33	15.64	14.72	15.18
TL/HD	28	24.67	24.68	25.14	27.08	27.82	24.88	25	25.97	27.21	22.08	24.74
TL/LCP	3.45	3.48	3.73	3.74	3.82	4.37	4.35	3.63	3.58	3.82	3.75	4.15
TL/BD	22.1	20.25	20.56	20.69	22.11	23.5	20.24	20.38	22.02	21.69	21.2	19.64
HL/GOM	3.07	2.69	3.23	3.08	3.39	2.21	2.77	2.83	3.44	3.58	4.0	4.73
HL/IOL	4.1	4.23	4.22	4.18	4.60	4.32	4.76	3.95	4.05	4.28	4.5	4.58
TL/UJL	31.7	24.67	30.85	30.27	31.59	30.35	28.11	24.09	29.24	29.93	22.08	30.92

In the present study head width, post-orbital length, head depth and body depth where range difference is greater than 10% can be considered as genetical characters. Head length, where range difference is 10–15% can be considered as intermediate character and length of caudal peduncle, pre-orbital length, upper jaw length, lower jaw length, gape of mouth and inter-orbital length where range difference is greater than 15% can be considered as environmentally controlled characters according to the classification given by Johal *et al.*, (1994).

Johal *et al.*, (1994) reported 13 characters in relation to total length to be genetically controlled in *Tor putitora*.

Bhatt *et al.*, (1998) reported 11 characters in relation to total length to be genetically controlled in the same species. This knowledge is important since Vladycov (1934) maintains that in the fish species showing restricted distribution, the majority of morphometric characters show narrow range

and are genetically controlled. On the contrary in species which have a wide range of Zoogeographical distribution, most of the characters are strongly influenced by the environment. These characters can be used to compare other populations of the mud eel *Monopterus cuchia* and to study the tendency of subspeciations if any.

Variations in the body proportions in the same species according to hydrographic conditions have been reported by various authors. Hubbs (1922), Burlow (1961) associated these variations with the effect of the duration of the periods of growth and of the relating differenciations which determines the number of vertibrae and of segments. The cause of variation in the morphometric and meristic characters may range from genetic variability to the influence of environmental parameters (Mottugh, 1954). Habitat, temperature, elevation, slope, gradient, stream velocity, food, productivity, length, sex and age also affect (Hubbs, 1922; Barlow, 1961; Hempel and Blaxter, 1963; Hopkrik, 1973 and Krika, 1974).

SUMMARY

Morphometric characters of the mud eel *Monopterus cuchia* (Ham.) from the new alluvial zone of West Bengal has been analysed. The morphometric characters of the species showed a proportional positive growth with the increasing length of the fish and a high degree of positive correlation with the reference length. Biometric index of *M. cuchia* studied indicates that the indices of length of caudal peduncle, gape of mouth and interorbital length was almost constant. The indices of the growth of head depth and body depth in relation to total length and upper jaw length in relation to head length was found to be allometric. Considerable difference in the morphometric characters has been observed between males and females in their head regions. Variations have also been observed between the dark and white variety of *M. cuchia* between various characters.

ACKNOWLEDGEMENTS

The authors are indebted to Director of Research, BCKV for his help and encouragement. This work was supported by the research grant 4(58)/98-ASR-1-1-8-2000 from the Indian Council of Agricultural Research, New Delhi (to MD), DJ is grateful to ICAR for providing Senior Research Fellowship for the work.

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DESCRIPTION OF THREE SPECIES OF INDIAN MANTIDS (INSECTA : MANTODEA) FROM MAHARASHTRA

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INTRODUCTION

This paper illustrates the hitherto unpublished females of *Amantis subirina* and *Deiphobe brevipennis.* Along with this, additional character variation as observed in female of *Hierodula assamensis* is also provided. Photographs of relevant parts are included here. In remark, dispute regarding type location is given.

DESCRIPTION

1. ***Amantis subirina*** Giglio-Tos 1915
(Pictures 1a and 1b female)

Body blackish (both dorsally and ventrally). Frontal sclerite trapezoid (upper side nearly straight), entirely black, no carina. Edge of vertex a little above eyes, 4 grooved, juxtacular lobes a bit prominent, with scattered brownish spots. Ocelli minute. Pronotum dorsally with scattered brown spots, margins finely toothed at prozona (less prominent in metazona); surface with distinct bosselles of which two basal are most prominent. Fore coxa without any colour patch (excepting a small black patch at base (internally); with minute spines at anterior edge; internal apical lobes divergent. Fore femur triangular, externally with 3 brownish bands, internally entirely black (except at claw groove and in the middle of claw groove and distal end); claw groove towards base; discoidal spines 4 in number, almost black and blackish near base; internal spines 11 in number, entirely blackish (except near base) and black at tips; external spines 4 in number, (coloured as internal

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spines); proximal two external spines closer to each other. Fore tibia with 10-11 external and 11 internal spines; all tarsal segments black (1st one is black except near basal part). Fore and hind wing pads are continuous with tergal plates. Middle and hind femora and tibia triannulated by brown ((less on posteriors). Hind metatarsus as long as (appears a bit longer than) rest segments taken together.

Measurements (mm) : Total length 14.0, pronotum 3.5, fore coxa 4.3, fore femur 3.8, fore tibia 2.1.

Material examined : 1 female, collected at Amboli Ghat, Maharashtra, 24/10/2004, coll. Ashok Captain.

Remark : The female of this species was not described before. The specimen was observed to lay eggs and hence it a mature female with reduced wings. Ehrmann (2002) mentioned the type male is in Zoological Survey of India but this was not found.

Distribution : India : Assam, Maharashtra, West Bengal.

2. ***Deiphobe brevipennis*** Sjöstedt 1930

(Pictures 2a and 2b, female)

Colour brown. Frontal sclerite narrow. Pronotum with both edges beset with blunt whitish tubercular spines; carina raised and tuberculated; entire dorsal surface beset with minute tubercles; metazona ventrally with a pair of oval elongated mark. Fore coxa with whitish tubercular spines; internal apical lobes divergent, with a black spot ventrally at coxal joint (in male). Fore coxae a little shorter than metazona. Fore femur with 4 discoidal, 4 external, and 14 internal spines and all black at tips only; no visible serration along outer margin (except rows of granular structure on inside along the outer spines and such rows are also seen on disc of femur); claw groove almost in the middle. Fore tibia with 8–9 external spines, 12–13 internal spines and all black at tips. Middle and hind tibia ventrally spinulated (more distinct on middle tibia). Spinulation on middle and hind femora not visible. Fore wing opaque; costal area pale yellow, discoidal area brownish, anal area black. Hind wing similarly coloured but the discoidal area posteriorly mixed with black; anal area black. Supra anal plate longer than broad, keeled and apex acute-angular, extends beyond the abdominal tip.

Measurements(mm) : Total length G 53.0, E 58.0; pronotum G 18.0, E 20.0; metazona G 13.5, E 14.0; fore coxa G 9.5, E 11.0; fore femur G 12.0, E 14.5; fore tibia G 4.5, E 6.0; length of supra-anal plate G 5.0, E 3.2; fore wing pad G 7.0, E 6.7.

Materials examined : One male and one female, collected on Torna fort, Maharashtra, October 2004, coll. Ashok Captain.

Remarks : So far un-described female has been described here along with other characters. Some important characters observed are : fore tibia with 8–9 external spines and 12–13 internal spines (all black at tips); fore wing with black anal area; hind wing with the discoidal area mixed with black at posterior part and its anal area black; supra anal plate longer than broad, keeled.

Distribution : India : Himachal Pradesh, Maharashtra.

3. ***Hierodula assamensis*** Mukherjee 1995
(Pictures 3a and 3b, female)

Body brown. Frontal sclerite transverse, carina not distinct, upper margin very widely arched. Pronotum finely serrated along edges. Metazona almost as long as anterior coxa, carinated, prosternum with two blackish bands towards basal area and the posterior band more black; mesosternum black at anterior area that bears a pair of rounded and a bit elevated whitish spots. Fore coxa with four whitish, obtuse tubercular premarginal spines and few similar spinules among them; no callous spots inside the coxa; narrow black band at apices of internal apical lobes . Fore femur deep brownish; discoidal and longer internal spines (7 in number) and their bases are reddish-brown (sockets are deep brown and one socket of longer internal spine black); 15 internal spines in total. Fore tibia with a distinct black spot at proximal dorsal end; with 12–14 internal and 11 external spines; tarsal segments black at distal ends (both externally and internally). Fore wing brown, with colourless punctures; stigma nearly rectangular and cream-yellow; hind wing transparent. Four posterior femora with apical spines.

Measurements (mm) : Total length 69.0, pronotum 21.5, metazona 15.0, fore coxa 13.5, fore femur 19.0, fore tibia 8.5, fore wing 53.0, hind wing 46.5.

Material examined : One female, Collected in Pune off Sholapur Road (Pune Wanowari Road), February 2004, coll. Rahul Paturkar.

Remarks : The additional characters of the present female of this species are : frontal sclerite without visible carina, upper margin covex (i.e., very widely arched); prosternum with two blackish bands towards basal area (posterior band deeper black); fore coxa with apices of internal apical lobes with narrow black band; fore tibia with a distinct black spot at proximal dorsal end.

Distribution : India : Arunachal Pradesh, Assam, Maharashtra, Meghalaya.

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PLATE I

1a

1b

Picture 1a : *Amantis subirina,* entire; **Picture 1b :** *Amantis subirina,* head and frontal sclerite.

PLATE II

2a

2b

Picture 2a : *Deiphobe brevipennis,* dorsal view; **Picture 2b :** *Deiphobe brevipennis,* ventral view

PLATE III

3a

3b

Picture 3a : *Hierodula assamensis*, Ventral; **Picture 3b :** *Hierodula assamensis*, dorsal view.

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SURVEY OF NON-HUMAN PRIMATES OF NAYAGARH DISTRICT OF ORISSA, INDIA

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INTRODUCTION

Field studies on non-human primates of Orissa was undertaken by Zoological Survey of India during 1978 under a project on Non-Human Primates of India (Tiwari and Mukherjee, 1992). Behura *et al.* (1969) reported the wildlife fauna of Orissa; Tiwari *et al.* (1997) published the sightings of monkeys at Chandaka Wildlife Sanctuaiy. Nayagarh district earlier was in the Puri district. The Puri district was divided into three districts in the year 1994, the other districts are Puri and Khurda. This report deals with the information regarding distribution, abundance, social composition and status of rhesus monkey (*Macaca mulatta*) and Hanuman langurs (*Semnopithecus entellus*) of Nayagarh district, Orissa. In this district, the rhesus monkeys were strictly restricted in the forests and hills while the Hanuman langurs were distributed both in the hills and in the village fringes and towns. These two common species of monkeys that are found in many parts of India, inhabiting in diverse habitats from dense forests to open lands and human habitation as also in montane and arid zone.

STUDY AREAS

Nayagarh district is situated somewhat in the southeast part of Orissa, lies between 84°30'–85°19' E longitude and 19°54'–20°34' N latitude. The area of the district is about 3954^2 km with a human population of 196 people/km^2 (2001 census). The configuration of the land displays a promiscuous and broken mountain system intersected by numerous plains and valleys. The rise and fall of the hills do no follow any systematic order. The hiss and dales are interspersed by many nallas and rivers. There are also many isolated scattered hills throughout the district. The highest peak is about 855 m. The alluvium soil are very much limited in this area and are mainly confined to the banks of river and other watercourses. Laterite soil and redloam cover the large areas of the district.

The mean maximum and minimum temperature varies from 44°C to 11.6°C depending upon the seasons. The district shows that the summer is hot and the winter is mild. Average rainfall per year approximately 1130 mm. Mahanadi is the main river, which flows on its northern boundary.

The total area of the district under forest cover is about 1160^2 km, which forms 31% of its total geographical area. The major trees are *Mangifera indica*, *Terminalia arjuna*, *Terminalia tomenstosa*, *Terminalia belerica*, *Delbergia paniculala*, *Buchanalia lanzan*, *Anogeissus latifolia*, *Hymendictyon excelsum*, *Bridelia retusa*, *Diospyros melanoxyion*, *Strychnos nuxvomica*, *Schleichera oleosa*, *Mirtragyna parvifolia* and few sal (*Shorea robustd*) plantations. Bamboos are very common plants in the hills.

METHODS

The survey methods applied in Nayagarh district were the same that was adopted in Purulia district survey of West Bengal (Chaudhuri *et al.* 2004). The observations were carried out both on foot and by a vehicle. Villages, towns, temples, roadsides and forests in the plains were surveyed. The point method was adopted for locating monkeys in the hills. Total count and sweep sampling methods were used to estimate the population. The survey was carried out from 0700 to 1130 hours and again from 1500 to 1800 hours with three observers. The field trip was made during August-September 2005. A total of 150 hours were spent in the census work. About 1580-km^2 area was surveyed. The groups when located, their social structure, habitat, inter-intra group interactions were recorded. The individuals of a group were broadly classified as adult males, adult females, juveniles and infants. The sub-adults of the groups were placed in the juveniles and adults population depending upon their age and size.

RESULTS

A total of 1580-km^2 was surveyed which comprised about 40% of the total geographical area of Nayagarh district. 30 groups of Hanuman langurs and 10 groups of rhesus monkeys were observed. These 30 groups of Hanuman langurs were sighted in the villages, hillforests and towns (Fig. 1). As the majority of the villages and towns of the Nayagarh district were having hills/ hillocks within the villages and towns and the langurs inhabited both in the plains and hill habitats in some period of a year so, the groups were not classified in habitatwise categories.

Hanuman langur : The 30 langurs groups contained 748 individuals of which 48 were adult males; 391 were adult females; 133 were juveniles and 157 infants. The social composition and distribution of langurs are given in Table-1. One group of langur, composed of one sub-adult male and one sub-adult female, was recorded at Khomarshai village, c.14 km from Daspalla town. Local inquiry revealed that in early 2004, a group of 11–12 langurs inhabited in this area and subsequently left the village and move towards the nearby hillock leaving behind these two

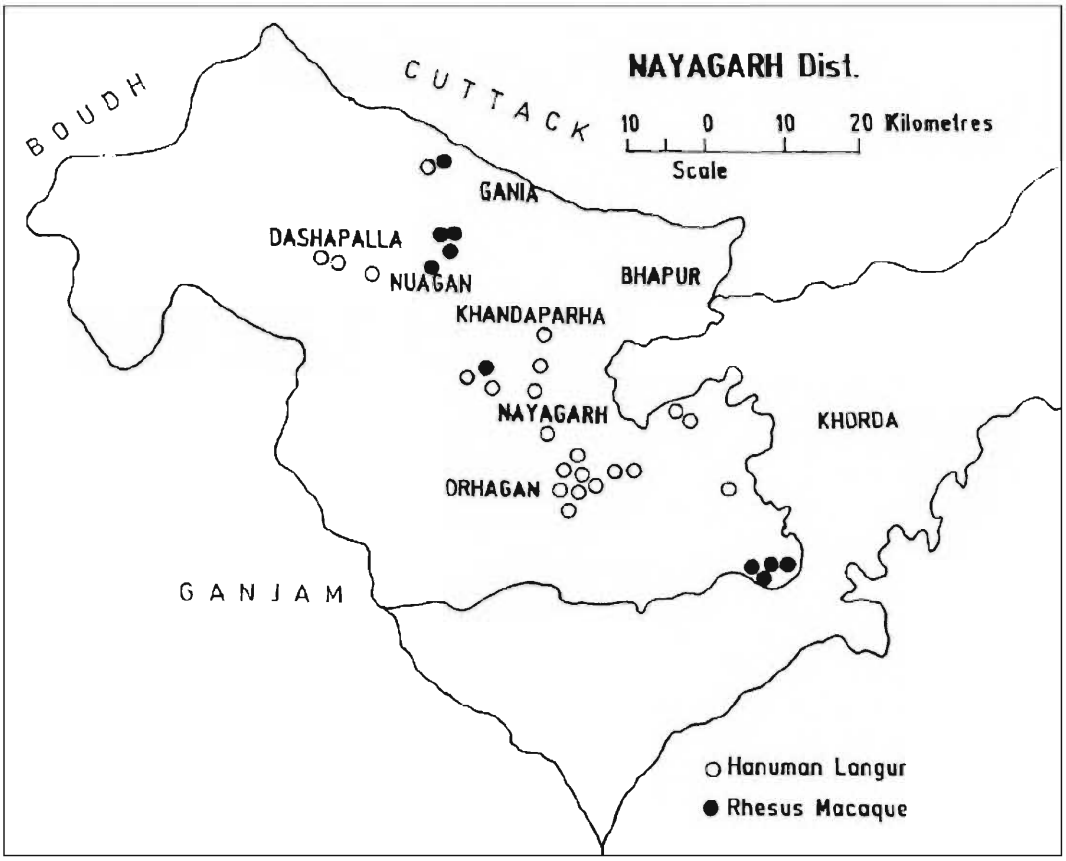

Fig. 1. : Distribution of Hanuman Langur and Rhesus Macaque.

individuals, those were juveniles at that period. These two langurs now became at sub-adult stage and inhabiting in the roadside trees of Khomarsahi village. We tried to understand from the villagers what cause or threat forced the group to move out leaving behind the juveniles, which did not show the natural phenomenon in primates. Moreover, the village contained sufficient feeding trees and good shelter for the langurs to harbour. The villagers however, did not confirm anything. These two sub-adults were not taken into account during the analysis of data. The group size varied from 10 to 42 langurs. The mean group size was 24.9 ± 1.92 (Fig. 3). This provides a population estimate of 0.02 groups/km^2 and 0.49 langur/km^2. The mean density of Hanuman langur is shown in Fig. 3.

Out of 748 langurs the percentage composition in the population were 8.95% adult males; 52.27% adult females; 17.78% juveniles and 21.0% infants (Table 1). About 40% females were having infants. The ratio of adult males to adult females was 1 : 5.8 and adult females to infant were 1 : 0.40. The ratio of adult females to combined population of sub-adults was 1 : 0.74.

Table 1. : Group size and distribution of bisexual Hanuman Langurs in Nayagarh-2005.

Sl. No.	Locality	Total	Adult Male	Adult Female	Juvenile	Infant
1.	Raghunathpur	12	1	7	2	2
2.	Kotagarh	21	2	11	4	4
3.	Sarendopur	22	3	11	3	5
4.	Sarendopur	17	2	8	3	4
5.	Lodhyachu	30	3	17	5	5
6.	Solapata	40	3	24	5	8
7.	Kalyanpur	19	2	12	2	3
8.	Kalyanpur	42	4	22	6	10
9.	Sabdevpur	38	3	21	6	8
10.	Vinayakpur	34	2	19	5	8
11.	Sarankul	25	2	14	3	6
12.	Kotadhari	21	2	13	2	4
13.	Durdua	43	4	20	11	8
14.	Kusthachandrapur	10	1	5	2	2
15.	Kadua	36	2	18	3	13
16.	Hatkada	20	2	10	3	5
17.	Nayagarh	15	2	8	2	3
18.	Daspalla	20	2	11	3	4
19.	Korada	14	1	8	3	2
20.	Andarkote	10	1	6	1	2
21.	Khandapara	19	2	11	2	4
22.	Lankasahi	16	2	9	2	3
23.	Madhupura	23	2	12	6	3
24.	Balugaon	24	2	14	5	3
25.	Govindapur	37	3	19	7	8
26.	Kalimati	31	3	15	7	6
27.	Gopalpur	14	1	7	3	3
28.	Ranpur	19	2	9	5	3
29.	Kontilo	47	4	17	15	11
30.	Khandapara	29	2	13	7	7
	Total	**748**	**67**	**391**	**133**	**157**
	Mean	**24.93 ± 1.92**	**2.23 ± 0.16**	**13.03 ± 0. 94**	**4.43 ± 0.54**	**5.23 ± 0.53**
	%		**8.95%**	**52.27%**	**17.78%**	**21.0%**

In 1978 Zoological Survey of India team was conducted field surveys in Puri district under a DST Project. Nayagarh is a part of the then Puri district later it was raised to a separate district. 16 social groups of Hanuman langur and 1 all male group was recorded with a total of 217 individuals from Nayagarh part survey (unpublished). Tiwari and Mukherjee (1992) published the account of non-human primates of Orissa containing a number of districts, but no separate district wise results were mentioned. The all male group was consisted of 5 langurs. The 16 bisexual langur group consisted of 212 langurs with an average group size of 13.25 ± 1.63 individuals. These social groups composed of 20 adult males (1.25 ± 0.11); 123 adult females (7.69 ± 0.93); 43 juveniles (2.69 ± 0.55) and 26 infants (1.63 ± 0.45) (Fig. 3). The group size varied from 4 to 26. The adult males to adult females' ratio were 1 : 6.15. Adult females to juveniles and infants ratios were 1 : 0.35 and 1 : 0.21 respectively. The percentage composition of different sexes and age class was 9.43% adult males, 58.0% adult females, 20.3% juveniles and 12.27% infants. 21.1% females were carrying infants.

Rhesus macaque : In Nayagarh district 10 groups of rhesus monkeys were recorded in 2005 survey. The areas and the distribution of monkeys are shown in Fig. 1. The 10 groups contained a total of 292 monkeys and the composition consisted of 36 adult males; 152 adult females; 52 each were juveniles and infants. The rhesus population of 2005 survey is shown in Fig. 2 The mean group size was 29.2 ± 1.84 individuals per group of which 3.6 ± 0.31 were adult males; 15.2 ± 1.10 were adult females; 5.2 ± 0.63 were juveniles and 5.2 ± 0.61 infants (Fig. 4). The group size varied from 21 to 41 monkeys. The percentage composition of 292 monkeys were 12.3% adult males; 52.1% adult females; 17.8% each were juveniles and infants. The adult males to adult females' ratio were 1 : 4.22 and adult females to juveniles and infants' ratios were 1 : 0.34 each. About 34.2% females were seen carrying infants. The distribution and social composition are given in Table 2.

During 1978 census, a total of 6-rhesus monkey groups with a total of 360 monkeys were recorded. The average group size was 60 ± 13.25 monkeys per group of which 6.50 ± 1.45 were adult males; 22.67 ± 4.88 were adult females; 20.00 ± 5.39 were juveniles and 10.83 ± 2.44 infants (Tiwari and Mukherjee, 1992). Out of 360 monkeys, 39 were adult males, 136 were adult females, 120 were juveniles and 65 infants. The results of 1978 and 2005 surveys are shown in Fig. 4. The adult males to adult females ratio was 1 : 3.48 and adult females to juveniles and infants ratios were 1 : 0.58 and 1 : 0.47 respectively. The number of infants was considerably low in the population. 47.8% females were carrying infants. The percentage composition consisted of 10.8% adult males, 37.8% adult females, 33.4% juveniles and 18.0% infants.

DISCUSSION

The rhesus monkeys of Nayagarh district were seen inhabiting in the forests and in the hills. These monkeys were reported to invade in the agricultural fields during crop raising time and

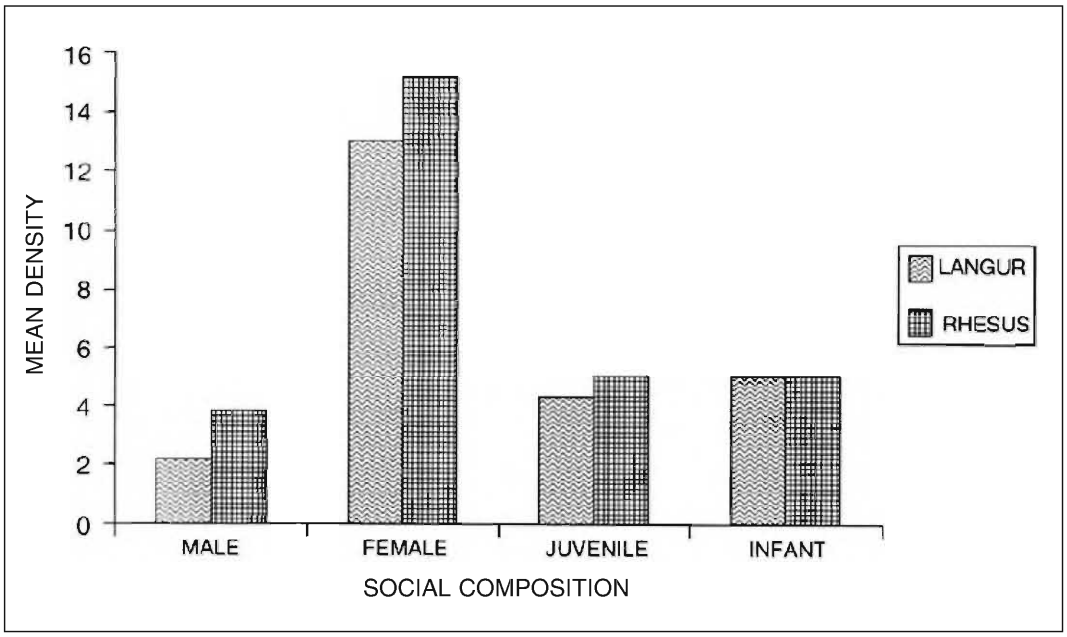

Fig. 2. : Hanuman langur and Rhesus macaque population of Nayagarh-2005.

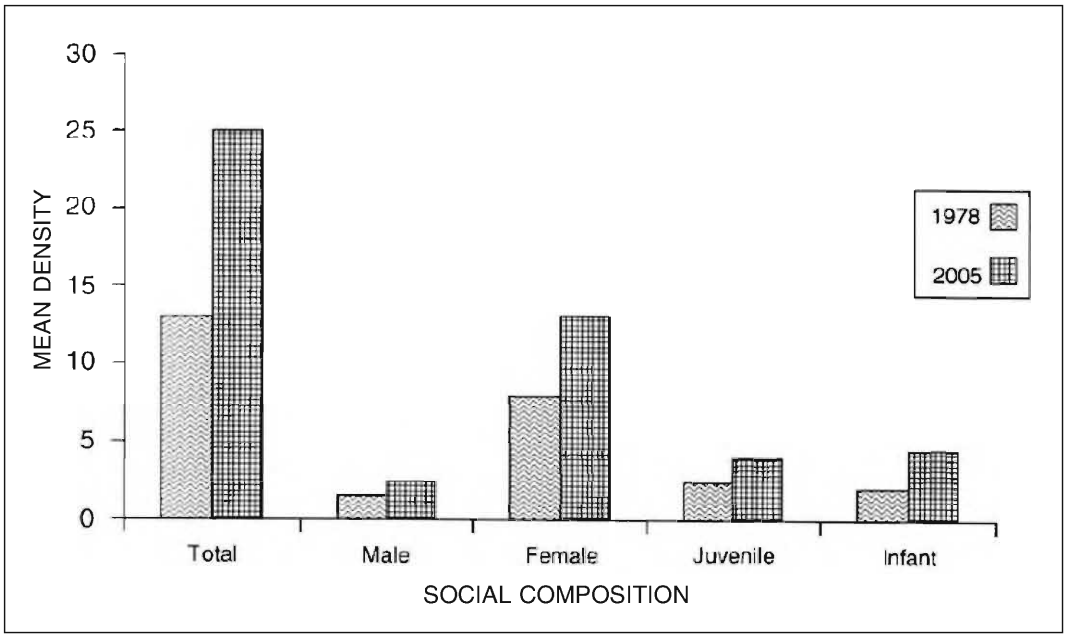

Fig. 3. : Mean density of Hanuman Langur of Nayagarh.

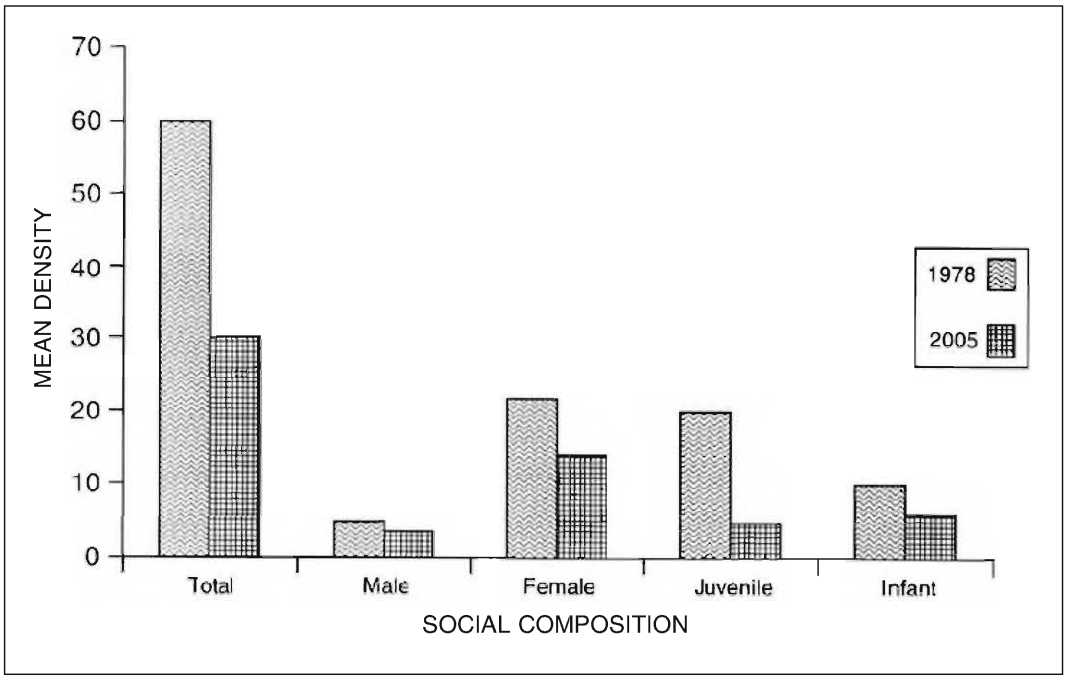

Fig. 4. : Mean density of Rhesus Macaque of Nayagarh.

Table 2. : Group size and distribution of Rhesus macaque of Nayagarh districi-2005.

Sl. No.	Locality	Total	Adult Male	Adult Female	Juvenile	Infant
1.	Kustha Chandrapur	21	4	9	5	3
2.	Baka Forest	41	6	22	9	4
3.	Baka Forest	26	4	13	7	2
4.	Patichandi	30	3	14	7	6
5.	Korado	30	3	16	5	6
6.	Kuanria Forest	34	4	17	5	8
7.	Kuanria Forest	22	3	12	3	4
8.	Kuanria Forest	29	3	16	3	7
9.	Lankasahi	32	3	17	5	7
10.	Ramchandi	27	3	16	3	5
	Total	**292**	**36**	**152**	**52**	**52**
	Mean	**29.2±1.84**	**3.6±0.31**	**15.2±1.10**	**5.2±0.63**	**5.2±0.61**
	%		**12.3%**	**52.1%**	**17.8%**	**17.8%**

maize cultivation. The hill forests of Nayagarh provides food and shelter to these monkeys from July to early part of January. After that due to scarcity of water and food the monkeys took shelter in the villages and roadside trees. The majority roads in this district having big trees on either side, of which mango is the predominant one. So, there is two type of habitat for most of the monkey groups-7 months in the hill forests and 5 months in the villages. The Hanuman langurs on the other hand inhabited both in the villages, towns and hills but they regularly visited both the places without maintaining any specific time period. Villages and fotrests of Nayagarh district represented the most favourable habitat categories for both the species of monkeys as they contained a variety of trees and plants.

The 1978 survey was conducted in the month of May and the present survey was conducted during September-October 2005. Therefore, the comparison of the two surveys was not possible for significance tests; moreover, the habitable areas were also different. However, from the recorded data of the two surveys revealed that the rhesus population did not vary much, only the group size was decreased. During 1978 census the group size was between 48 and 90 individuals but in 2005 survey it was found the largest rhesus group contained only 47 monkeys. Latest survey also revealed that the Hanuman langur population was increased considerably and occupying the most of the areas of the district. This resulting in direct competition with the rhesus monkeys in respect of food and shelter. In 1978 survey only 217 langurs were recorded in 17 groups whereas during the 2005 survey 30 groups with a total of 748 langurs were observed. So, there was more than three-time increase in the langur population over the years. It also showed that rhesus monkeys could not able to flourish at the same pace though good forest cover (31%) still exists in this district.

Man-monkey interactions were very less in this part of Orissa. The monkeys in Orissa enjoyed protection due to religious and philosophical belief till today. In other states of India, these monkey now days have come increasingly intolerant to the people. The taboos had broken down and people particularly the villagers considered the monkeys' agricultural pests. Hopefully, this factor did not affect in Orissa as such the monkeys inhabit in the state without any major interaction with the people.

ACKNOWLEDGEMENT

The authors are thankful to the Director, Zoological Survey of India, for his keen interest and providing all facilities to carry out the work.

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Rec. zool. Surv. India : **107**(Part–2) : 45-50, 2007

NOTES ON THE GENUS *EUASPA* MOORE (PAPILIONOIDEA : LYCAENIDAE : THECLINAE) FROM NORTH-WEST INDIA

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INTRODUCTION

Moore (1884) proposed the genus *Euaspa* on the type-species *Myrina milionia* Hewitson and characterized the same on the basis of some external morphological characters, which according to de Niceville (1890) are very erroneous. Though the latter author improved upon the generic diagnosis by incorporating wing venation but he did not study the external genitalic characters of the type-species. In view of insufficient characterization, Shirozu and Yamamoto (1956) examined the external male and female genitalia of the type-species and updated the diagnosis. Four species of this genus are reported form world over (Bridges, 1988) of which three species (Varshney, 1997) are found in India. Among them, two species viz. *milionia* Hewitson (type-species) and *ziha* Hewitson are met with in North-West India. During the present studies, both these species are examined and the generic diagnosis updated adding characters such as labial palpi and wing venation. This genus is peculiar in subfamily Theclinae owing to the presence of undivided uncus in the male genitalia. The male and female genitalia of these two species have been studied in details.

OBSERVATIONS

Genus ***Euaspa*** Moore

1884. Moore, *J. asiat. Soc. Bengal*, pt II **53**(1) : 29.

1890. de Niceville, *Butts India Burmah Ceylon*, **3** : 309.

1956. Shirozu and Yamamoto, *Sieboldia*, **1**(4) : 368.

1963. Cantlie, *Lyc. Butts Revised* : 9.

Type-species ***Myrina milionia*** Hewitson

1869. Hewitson, *Ill. Diurn. Lep. Lycaenidae* **1** (Suppl.) : 5.

Generic diagnosis : Frontoclypeal area clad with black hair and a white median streak; eyes sparsely hairy; second segment of labial palpi hairy; antenna with undifferentiated cylindrical club, nudum goes deep into flagellum; each leg with femur hairy; hind wing tailed at vein Cu1b, forewing with 11 veins, stalks of veins R3 + R5 and vein M1 common at origin; male genitalia with uncus undivided, elongated, at base socii present; valva basal half broad with elongated apical processes, base of ductus bursae sclerotized, ductus seminalis entering near the base, corpus bursae elongated, with a pair of signae.

Key to the species of the genus ***Euaspa*** Moore from North-West India

1. Fore wing and hind wing with broad discal patch on upper surface, undersurface of both wings with broad white discal bands; vein R3 originate from vein R5 nearer apex; male genitalia with apex of uncus rounded; female genitalia with base of ductus bursae well sclerotized, funnel-like ..... ***milionia*** Hewitson
2. Fore wing with two minute discal white spots on upper surface, hind wing without any white patch dorsally; undersurface of both wings with linear bands; vein R3 originate from vein R5 nearer to end of discal cell; male genitalia with apex of uncus pointed; female genitalia with base of ductus bursae narrower, not funnel-like ..... ***ziha*** Hewitson

Euaspa milionia (Hewitson)

Plate–I(A)

1869. Hewitson, *Ill. Diurn. Lep. Lycaenidae*, **1** (Suppl.) : 5 (*Myrina*).

1890. de Niceville, *Butts India Burmah Ceylon*, **3** : 310 (*Euaspa*).

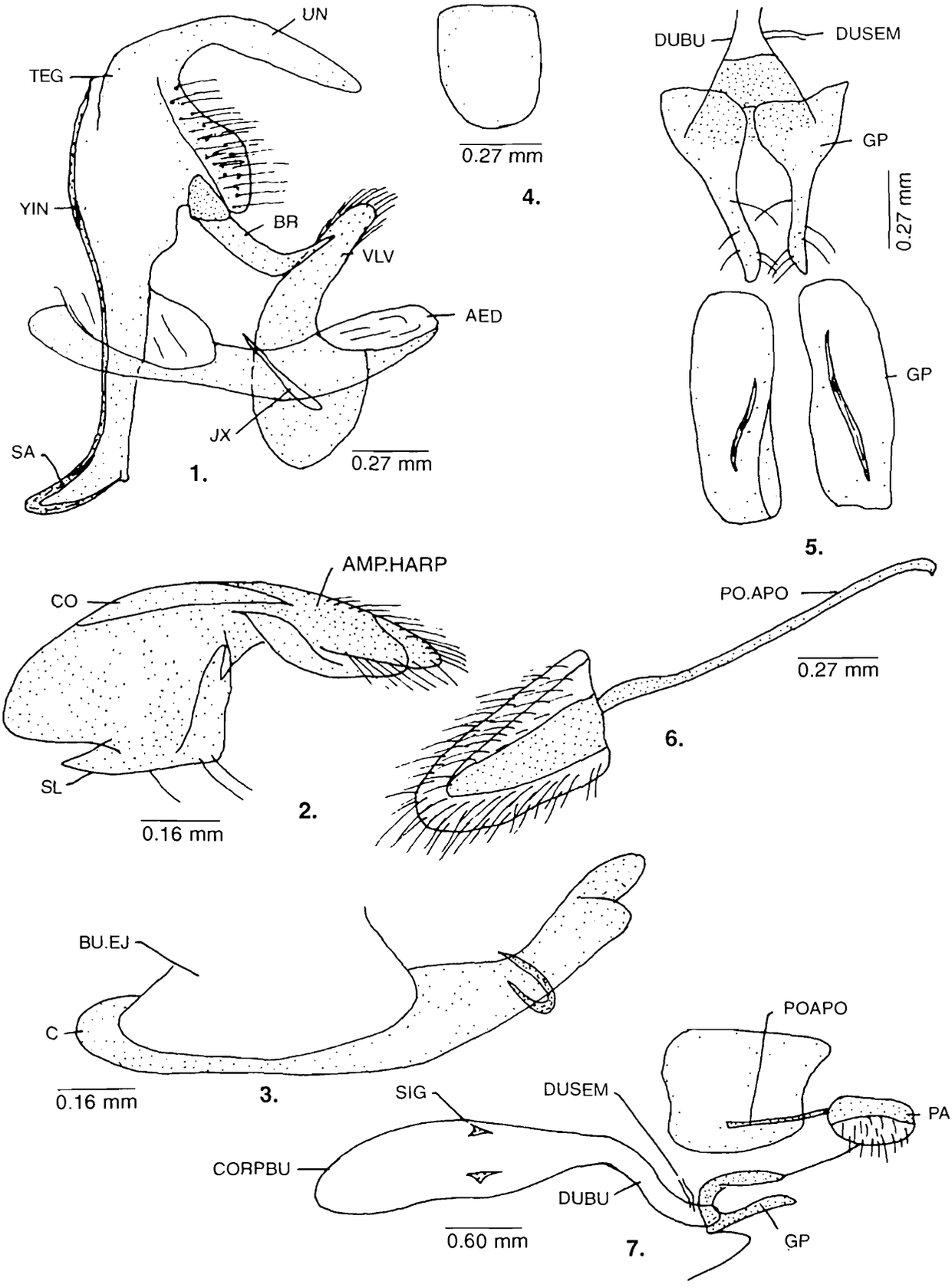
Common name : Water Hairstreak.

Male genitalia (Figs. 3-5) : Uncus undivided, elongated, tubular, rounded distally with socii pilose; brachia long, slender, curved; tegument broad; vinculum straight, ends into short saccus; valva broader in upper half, with abruptly narrow elongated apical process, pilose; juxta cresent-shaped, narrow; aedeagus short, spatulate at apex, bulbus ejaculatorius entering widely dorsally, coecum rounded.

Female genitalia (Figs. 6-9) : Lodix oval; genital plate with two pillar like, weakly sclerotized processes ventrally; ductus seminalis attached near base of ductus bursae; the latter well sclerotized, siphon-like at base, slender; corpus bursae elongated, with a pair of signae; apophysis anterioris absent; apophysis posterioris curved near base, hooked at apex; papilla analis elongated, pilose.

Wing expanse : Sexes similar : 17.0–17.5 mm.

Material Examined : H.P. : 1 ♀ 20.VII.1992, Dharwas, Chamba (Pangi valley, Pir Panjal range), coll. H.S. Rose and A.K. Sidhu. Uttaranchal : 12 ♂, 9 ♀ 3.VI.1992–5.VI.1992; Mussoorie, Dehradun, coll. A.K. Sidhu; 10 ♂, 11 ♀ 24.IX.2005, Mussoorie, Dehradun, coll. A.K. Sidhu.



Figs. 1-7. : *Euaspa milionia* (Hewitson). 1. Male genitalia lateral view; 2. Valva (inner view); 3. Aedeagus (lateral view); 4. Lodix; 5. Genital plate; 6. Papilla analis; 7. Female genitalia (lateral view).

Range : 1440–3000 m ASL.

Former distribution : North-west Himalaya, Shimla, Kangra valley, Kumaon, Mussoorie, Dehradun, Khijjar, Nepal.

Remarks : This species is described from twenty two male and twenty one female individuals. The lone female specimen collected during the present study from an isolated locality *i.e.*, Pangi valley, falling in Pir Panjal range of Himalayas, forms the first record of the species from this locality. The female genitalia of this specimen is similar to the genitalia of individuals collected from Mussoorie.

Euaspa ziha (Hewitson)

Plate–I(B)

1869. Hewitson, *Ill. Diurn. Lep. Lycaenidae*, **1** (Suppl.) : 66 (*Dipsas*).

1890. de Niceville, *Butts India Burmah Ceylon*, **3** : 308 (*Zephyrus*).

1932. Evans, *Ident. Indian Butts* (2nd ed.) : 252 (*Thecla*).

1963. Cantlie, *Lyc. Butts Revised* : 91 (*Euaspa*).

Common name : White spotted Hairstreak.

Male genitalia (Figs. 12-14) : Uncus undivided, very long, apex pointed, with well produced, pilose socii; brachia very small, curved inwards, pointed; tegument broad; vinculum long, without saccus; valva oval, with a long narrow, downwardly curved process, pilose; juxta u-shaped, arms narrow; aedeagus short, dorso-ventrally flattened, apex spatulate, bulbus ejaculatorius dorsad, coecum rounded.

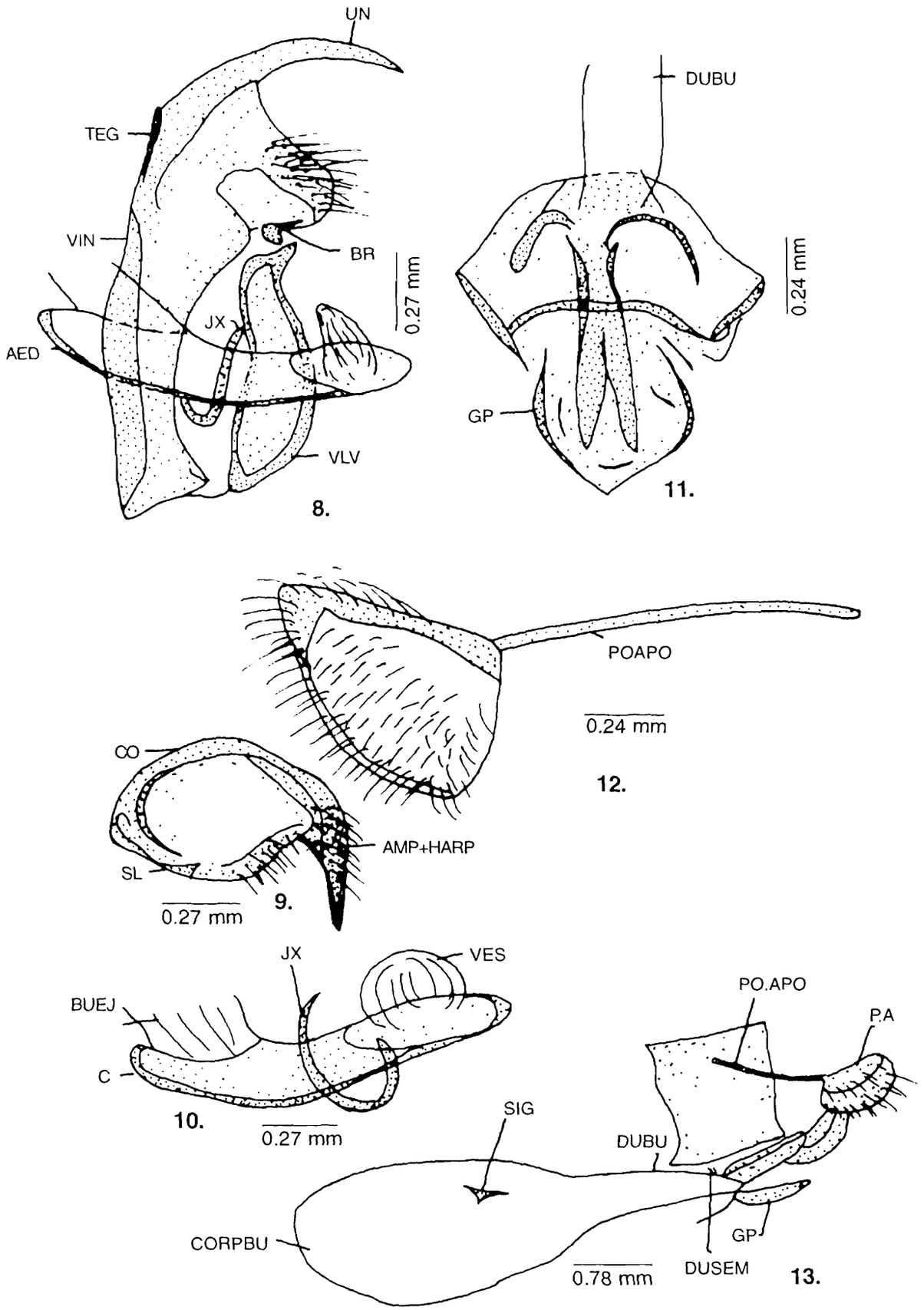
Female genitalia (Figs. 15-17) : Genital plate well developed, elongated and sclerotized, with a pair of well sclerotized processes; ductus seminalis entering near sclerotized basal portion of ductus bursae; the latter goes imperceptibly into very large, oval corpus bursae, a pair of triangular signae present; ends of eighth sternum produced into small, triangular anterior apophysis; posterior apophysis long, slender; papilla analis suboval, pilose.

Wing expanse : Sexes similar : 18.5–19.5 mm.

Material examined : Uttaranchal : 2♂, 3♀ 3.VI.1992–5.VI.1992, 1♂, 3♀ 24.IX.2005, Mussoorie, Dehradun, coll. A.K. Sidhu.

Former distribution : North-West Himalaya, Kullu, Shimla, Mussoorie, Dun Valley, Nilgiris.

Remarks : The male and female genitalia of this species are described for the first time. The critical examination of the various external morphological characters shows that the species conforms to the characterization of the genus *Euaspa* given by Cantlie (1963). The genitalic organs of the species studied presently are congeneric with those of the type-species, *Myrina milionia* transferred to the genus *Euaspa*. The present surveys also show that the species is moderately abundant in Mussoorie hills.



Figs. 8-13. : *Euaspa ziha* (Hewitson). 8. Male genitalia lateral view; 9. Valva (inner view); 10. Aedeagus (lateral view); 11. Genital plate; 12. Papilla analis; 13. Female genitalia (lateral view).

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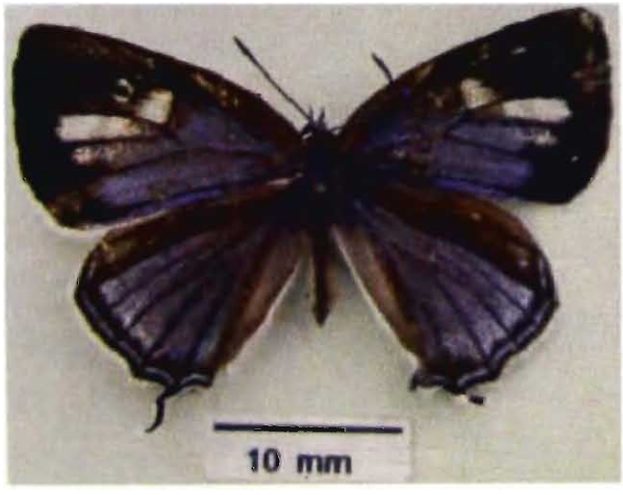
PLATE I

Dorsal side (Male) Ventral side (Male)

(A) : *Euaspa milionia* (Hewitson)



Dorsal side (Male) Ventral side (Male)

(B) : *Euaspa ziha* (Hewitson)

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PHYSICO-CHEMICAL CHARACTERISTICS AND ZOOPLANKTON OF HUSSAIN SAGAR LAKE, HYDERABAD, ANDHRA PRADESH

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INTRODUCTION

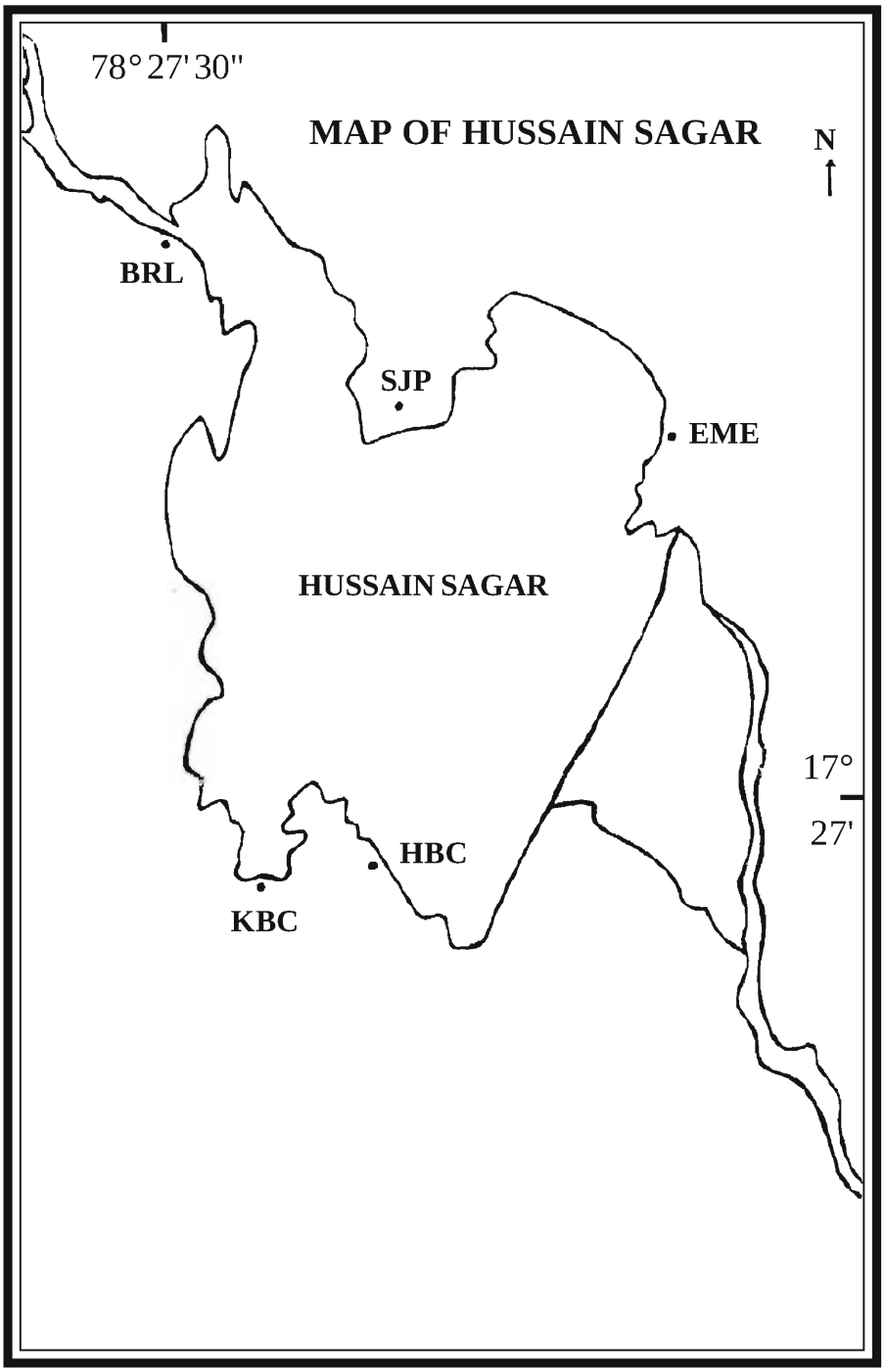
Hussain Sagar with an area of 450 hectares is one of the principal lakes located (78°30' E, 17°30' N) between the twin cities of Hyderabad and Secunderabad, Andhra Pradesh (Map 1). With passage of time, the lake is undergoing a steady degradation in its ecology due to urbanization and industrialization with consequent influx of domestic sewage and industrial effluents. Some important limnological and ecological studies on the Hussain Sagar Lake are by Zafar (1966), Khan and Hussain (1976) and Babu Rao *et al.* (1981). The studies made then indicated possible pollution from domestic and industrial origin. Later on, there has been considerable increase in the population as well as in the developmental activities in the capital in general and around the lake in particular and hence the present study.

MATERIAL AND METHODS

With a view to assess the condition of the lake, a study of the lake was undertaken for a period of 19 months from June 1990 to December 1991. For the study, five sampling stations in the lake were selected nearby five important landmarks around the lake on the basis of the topography, inflow of pollutants and human activities (Map 1).

(a) **HYDERABAD BOAT CLUB (HBC) :** This station is situated in the eastern pocket at the southern end of the lake. Here the Budha statue was installed on the rock of Gibralter. Annually Ganesh idols are being immersed at this site.

(b) **KHAIRATABAD COLONY (KBC) :** This area is situated in the western pocket at the southern end, west of Hyderabad Boat Club and receives domestic sewage from the surrounding colonies. Here also, a lot of silt is added through immersion of Ganesh idols every year.



Map 1. : Map of Hussain Sagar.

(c) **BEGUMPET RAILWAY LINE (BRL) :** Situated in the northwestern pocket of the lake, this station receives the waste water from Kukatpally stream. Domestic sewage and industrial effluents from Kukatpally and Balanagar industrial areas are released into the lake at this point.

(d) **SANJIVAYYA PARK (SJP) :** This zone is situated between the northwestern and northeastern pockets of the lake. Laundry wastes from several *Dhobi Ghats* enter the lake at this point.

(e) **EME SAILING CLUB (EME) :** This station is situated north of the *Tank bund* skirting the eastern border of the lake. The area is mainly utilised for sports activities such as boating, sailing *etc.*

Surface water samples were collected at approximately monthly intervals from the above mentioned five stations for physico-chemical parameters. At each station, a separate sample was collected for estimation of Dissolved Oxygen with usual precautions. Temperature was measured using a centigrade thermometer and pH by 'dip pH' meter in the field. Standard Methods of APHA (Anon, 1989) were applied to measure the chemical parameters. Plankton samples were collected using plankton net of mesh size no. 25 and preserved in 4% formalin in plastic containers. Identification of zooplankton was done with the help of Pennak (1989), Edmondson (1969) and Michael and Sharma (1988).

RESULTS AND DISCUSSION

The ranges of different physico-chemical parameters of the water at five sampling points are pooled and given in Table 1. In general, the water of the lake is turbid, and the colour is brown to pond green with frequent emission of foul smell.

Physico-chemical parameters :

Temperature : Variation in air and surface water temperatures are due to changing seasons in general and variations at different stations on the same day are due to time lag in the collection of samples, which are spatially separated. The maximum atmospheric temperature was attained in all the spots during peak summer month of May which ranged from 36°C to 38°C. Minimum was noticed in winter season, which ranged between 25°C and 26°C at all the stations.

The surface water temperature varied from 24°C to 35°C. Highest was found in summer (35°C) followed by a low of 28°C during the monsoon and 24°C during winter. In general the water temperature closely followed the atmospheric temperature at the time of sampling with slight differences.

pH : The pH of the lake waters was generally alkaline (range–7.3 to 10) throughout the period of study. Highest values were recorded during summer months of March-May with a maximum of 10. During the rest of the period it was around 8 with a minimum of 7.3 during October 1991.

Table 1. : Ranges of Physico-Chemical Parameters of Hussain sagar lake.

Parameter	1990							1991											
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp. (Atm.)	31–34	28	30–32	28–29	29–30	28–29	28–29	25–26	24–30	35–37	36–37	36–38	27–28	28–29	25–27	29–34	27–28	25–26	27
Temp. (Water)	29–30	26–28	29–32	26–28	27–28	26–27	27–28	22–25	26–27	29–35	30–31	31–34	26–27	26–27	24–25	28–30	25–26	24–25	25–27
pH	7.9–9.4	7.8–8.0	7.6–8.5	7.6–8.1	7.6–8.2	7.8–8.2	8.0–8.3	8.1–8.5	8.4–8.5	8.9–10.0	8.6–9.5	8.2–9.5	7.9–8.2	7.8–8.0	7.8–8.1	7.4–8.3	7.3–7.6	7.6–8.1	8.2–8.6
Sp. Cond.	1470–1710	1435–1465	1495–1565	1480–1600	1425–1522	1500–1650	1550–1600	1725–1797	1715–1782	1782–1949	1810–2050	2109–2170	1808–1928	1500–1705	1259–1648	1658–1887	1380–1620	1628–1735	1684–1774
Dis. Oxygen	5.4–17.0	3.4–5.2	0–10.6	1.2–6.2	1.2–7.8	1.6–6.0	2.0–5.8	2.0–7.2	2.6–5.6	4.0–8.2	3.2–6.2	2.2–5.6	0.6–3.4	1.0–3.6	0–8.4	0–4.0	0–5.2	0–4.0	2.6–8.0
Carbonates	0–120	0	0–24	0	0	0	0	0–6	12–24	24–54	0–25	0–60	0	0	0	0	0	0	0–18
Bicarbonates	165–378	311–323	262–305	280–320	286–336	275–325	275–318	311–360	317–360	281–311	290–360	275–427	397–427	350–385	305–384	299–366	329–366	311–366	229–360
Free Co2	0–4.6	4.0–6.0	0–8.4	4.6–7.0	4.0–4.8	4.0–4.6	4.0–4.4	0–4.2	0	0	0–3.6	0–7.8	4.2–6.0	4.2–7.0	3.6–5.6	6.2–9.2	6.0–9.6	4.0–7.0	3.8–7.2
Chloride	262–920	273–284	269–280	230–275	230–245	240–260	250–265	273–291	280–294	319–337	300–340	347–372	319–337	298–332	225–337	300–370	250–312	227–290	270–287
Total Hard.	250–475	295–315	280–305	275–295	275–335	235–330	224–300	185–210	195–210	220–235	215–242	220–245	245–285	200–280	210–255	215–270	215–320	250–320	220–310
Calcium	56–76	76–80	74–92	74–87	70–80	58–90	42–84	44–50	46–58	42–50	43–55	40–52	58–62	36–58	40–54	50–72	50–84	34–58	20–36
Magnesium	24–74	23–29	13–29	18–28	21–39	25–32	23–30	15–24	11–21	23–32	26–31	19–34	22–33	26–30	24–30	21–23	22–47	27–46	38–63

The pH pattern was closely related to the carbonates, bicarbonates and free CO_2. High pH in summer correlated with high carbonate and bicarbonate values and low pH with presence of free CO_2. The same pattern was found in all the five stations.

Specific conductance : The range of conductivity during the study was 1259–3660 micro mho's/cm. Lowest values were observed during monsoon. The values gradually increased through winter to reach the maximum in summer.

High Specific Conductance indicates richness of ions necessary for organic production and the converse is also true. The high Specific Conductivity in summer could be due to concentration of domestic effluents containing nutrients, resulting from evaporation and no inflow of freshwater. This leads to variations in DO, nil under anaerobic conditions and high values under eutrophic conditions.

Dissolved Oxygen (DO) : During the course of study, the range of DO observed is 0 to 17 mg/1. The general range however is from around 2 to about 6 or 8 mg/1. High values of 10.6 mg/1, 12.2 mg/1 and 17 mg/1 were encountered which are exceptional. The station-wise ranges of DO values noticed are 1.4–12.2 at HBC, 1.8–17 at KBC, 0–5.4 at BRL, 0–5.8 at SJP and 3.0–8.2 at EME. Low values indicate organic enrichment resulting sometimes in anaerobic conditions. The same high content of nutrients also leads to eutrophication under suitable conditions of dilution and light penetration, resulting in extremely high DO. The high values of DO are due to high productivity during clear weather seasons. Exceptionally high values were the effect of eutrophication. Low values during monsoon are probably due to low sunshine coupled with poor penetration light resulting from high turbidity.

Carbonates, Bicarbonates and Free CO_2 : The maximum values of carbonate during the present study were 24 mg/1 at HBC and KBC, 48 mg/1 at EME and 54 mg/1 at BRL, 60 mg/1 at SJP, all in the month of March, excepting at SJP where it was in May. During the rest of the year the values were nil for the most part or only low. The value was exceptionally high, 120 mg/1 at KBC during June 1990. Zafar (1966) also found higher quantities of Carbonates during hot months. Highest values of about 400 mg/1 were observed at all stations during May-July period. During the rest of the period the values were around 300 mg/1 or more at all stations excepting at KBC where the minimum was 165 mg/1 during June 1990. Munawar (1970) noted higher bicarbonate contents in eutrophic waters and sewage pond respectively. Phillipose (1960) reported higher values of total alkalinity in polluted waters. As is well known, presence of free Carbon-dioxide indicates the absence of carbonates. Whenever it was present, the values ranged between 3.6 and 9.6 with maximum during late monsoon.

Chloride : The chloride content at all the five stations of the lake varied from a minimum of 225 mg/1 at BRL in August to a maximum of 372 mg/1 at SJP in May and 370 mg/1 at BRL in September. Exceptionally the value was 922 mg/1 at HBC in June 1990. The general range is

however from 270 mg/1 to 300 mg/1. Only at KBC the chloride content varied slightly around 260 mg/1 for a greater part of the year. High value in September immediately after the minimum in August suggest complicated processes in Hussain Sagar Lake and high variation in the discharges particularly of industrial origin.

Total Hardness (TH) and Calcium and Magnesium ions : The TH of the Hussain Sagar waters ranged from a minimum of 185 mg/1 in January 1991 at EME to a maximum of 475/1 in June 1990 at HBC during the study period. Generally the values were around 200–250 for the most period at all the places during 1991, while higher values around 300 were recorded during June to November-December period of 1990. The main source of calcium is rocks from which the rainwaters leach it. The values of Calcium ranged from 20–50 mg/1 (winter and summer) to 80–90 mg/1 (monsoon). The Magnesium values were generally between 20 mg/1 and 30 mg/1, sometimes around 10–15, with occasional high values of 40–50 mg/1 in Nov-Dec 1991 and an exceptional value of 74 mg/1 in June 1990. The TH is influenced by the Calcium and Magnesium ions in the water-body. These, though significant, showed only a little relationship with TH, indicating influence of variation in the inflow and content of other ions like iron, manganese, strontium *etc.* of freshwater as well as other discharges into the lake. The variation, thus, seems to depend on he varying contents and degree of different ions in the inflow.

Total Hardness is an indicator of water quality. Generally the desirable limit of this factor is 300 mg/1 with permissible limit up to 600 mg/1 as per Indian Standards (Anon, 1991). Thus the TH is within the desirable limit.

Zooplankton :

The composition of zooplankton in the lake shows the high species diversity of cladocerans (10 spp.) followed by that of rotifers (7 spp.) while ostracods were represented by three species and copepods by only two species. Following is the list of species encountered during the present study and those reported by Babu Rao *et al.* (1981).

Groups	Present Study	Babu Rao *et al.* (1981)
ROTIFERA	*Brachionus calycifloms* (Gosse, 1851)	*B. calycifloms*
	B. forficula Wierzeiski, 1891	*B. caudatus*
		B. quadridentata
		B. urceoloris
	Keratella tropica (Apstein, 1907)	*K. tropica*
	Filinia longiseta (Ehrb., 1834)	
	Mytilina sp.	
	Platiyas quadricornis Ehrb., 1882	*P. quadricornis*
	Lecane sp.	

Groups	Present Study	Babu Rao *et al.* (1981)
CLADOCERA	*Pseudosida bidentata* Herrick, 1884 *Diaphanosoma sarsi* Richard, 1984 *D. excism* Sars, 1885 *Ceriodaphnia cornuta Sars,* 1885 *Daphnia lumholtzi* Sars, 1885 *Simocephalus vetulus* (O.F. Müller, 1776) *Moina brachiata* (Jurine, 1820) *Moinadaphnia macleayi* (King, 1853) *Macrothrix spinosa* King, 1853 *Leydigia* sp.	 *Diaphanosoma sarsi* *Ceriodaphnia cornuta* *Ceriodaphnia* sp. *Daphnia lumholtzi*
COPEPODA	*Heliodiaptomus* sp. *Mesocyclops* sp.	*Heliodiaptomus* sp. *Mesocyclops leucartii*
OSTRACODA	*Cypris* sp. *Cyprinotus* sp. *Stenocypris* sp.	

A few studies on the zooplankton of Hussain Sagar were earlier made, chiefly by Babu Rao *et al.* (1981). Dhanapathi (1974) has reported 4 species of Rotifera *viz.*, *Brachionus falcatus*, *B. durgae*, *B. calyciflorus* var. *dorcas*, *Platiyas quadricornis* of which the first two are not encountered during the present study.

Among the rotifers collected from Hussain Sagar and listed above, occurrence of *Brachionus calyciflorus* and *Filinia longiseta* indicates eutrophic conditions of the lake. *Keratella tropica* prefers the polluted waters and *Brachionus forficula* prefers clean water. Presence of the genera, *Diaphanosoma*, *Ceriodaphnia* and *Simocephalus* is also indicative of eutrophic nature of the water body (Mahajan, 1981).

Based on the DO and species abundance ratios, Babu Rao *et al.* (1981) found the western and northwestern parts of the lake to be polluted and the fauna having the environmental stress. The DO was low at Station 2 (Western region) and nil at Station 3 (NW part) located on the western flank. During the present study the DO values in general are low, around 3 mg/1 at all the stations for most part of the year and occasionally nil or very low indicating organic load. High alkalinity, low Dissolved Oxygen with occasionally nil or very high values and presence in the zooplankton, *viz.*, rotifers, *Brachionus calyciflorus*, *Filinia longiseta* and *Keratella tropica*, and the cladocerans, *Diaphanosoma*, *Ceriodaphnia* and *Simocephalus* are some of the characteristics of the lake indicating of organic pollution and eutrophic nature of the water body. Thus during the decade from the studies of Babu Rao *et al.* (1981) the degradation has spread almost to the entire lake. Based on

different biotic and abiotic parameters, Siddiqi and Khan (2002) also classified the Hussain Sagar, as a highly eutrophic lake. It is possible, considering the rate at which the resident and floating population of the twin cities is growing and the rate of developmental activities that took place and are continuing, the condition of the lake further deteriorated needing a fresh look into the condition and control over the factors responsible for the deterioration.

SUMMARY

A limnological study on Hussainsagar, a highly eutrophic lake in Hyderabad, was undertaken during 1990-91. Twelve parameters were analysed and discussed with a brief note on its zooplankton composition.

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WETLAND FAUNAL RESOURCES OF WEST BENGAL. 5. BANKURA AND PURULIYA DISTRICTS

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INTRODUCTION

The present paper on wetland faunal resources of Bankura and Puruliya districts is the fifth report of the series from West Bengal. The earlier reports relate to faunal diversity of some wetlands of North and South 24 Parganas districts (Nandi *et al.*, 1993), Haora and Hugli districts (Nandi *et al*., 1999), Birbhum district (Nandi *et al*., 2001b) and Darjiling and Jalpaiguri districts (Nandi *et al*., 2005). Besides these reports, studies on wetlands of West Bengal, mostly pertaining to plankton and benthos, were made from Calcutta and it's surrounding areas of South Bengal (De *et al.*, 1989; Ghosh, 1990; Venkataraman and Das, 1993; Sinha and Khan, 2000; Nandi *et al.*, 2001a, Mukherji and Nandi, 2004). However, very little is known on overall freshwater fauna and/or wetland fauna of western highland and plateau region of lower West Bengal (Sen, 1992; Thakur *et al.*, 1992; Pattanayak, 1999; Mukhopadhyay, 1999; Sharma, 1999; Chandrasekhar, 2003; Nandi *et al.*, 2004). Thus, the present study was taken up to deal with wetland faunal resources of Bankura and Puruliya districts representing the Rarh (*Raktim* or red) plain (RP) and the undulating highland and plateau (HP) regions respectively.

PHYSIOGRAPHY

The districts of Bankura and Puruliya fall under the physiographic division, the central Rarh Plain and the entire Western Highland and Plateau regions of West Bengal. Bankura district excluding the narrow Western Highland portion lies on the slightly undulating Rarh Plain, while the whole of Puruliya district constitutes the highly undulating highlands, dotted with a number of rounded steep-sided hills called 'monadrocks' (O' Malley, 1908; Bhattacharya *et al.*, 1985; Banerjee, 1968).

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Bankura district lies between 22°38' and 23°38' North latitude and 86°36' and 87°46' East longitude, and is located on the western part of West Bengal. The district extends over the right bank tributaries (*viz.*, Damodar, Dwarakeswar, Silai and Kangasbati) basin of Bhagirathi Hooghly river covering a geographic area of 6,882 sq. km., with a population of 31.91 lakhs (as per 2001 census) *i.e.*, having 464 persons per sq. km. Puruliya district is located between 20°43' and 23°12' North latitude and 85°49' and 86°54' East longitude at the extreme western fringe of West Bengal, covering a geographic area of 6259 sq. km. with a population of 25.35 lakhs (as per 2001 census) *i.e.*, having 405 persons per sq. km. This region underwent a process of erosion and denudation through ages. It has now taken the landform of a rolling plain region called peneplain. Owing to excessive erosion and denudation, high hills are totally extinct and even the plateau has been transformed into smooth rolling barren upland. Low hills locally called Dungri or Tila (*pahar*) such as Ayodhya, Jabarban, Belasu, Panchet, Ramkenali, Bansha, Chunta, Parasha, Bagmundi, Daldungri, Gurma and Bhandara stand here and there in Puruliya district. Gorgaburu of Ayodhya hills is the highest peak (677 m) of the rolling upland region. The arid rugged part of the plateau of South Puruliya is locally called Barabhum. The Rarh plain of Bankura district appears to be even plain in some parts and rolling plain in other parts. It has very gentle slope to the east having its contour to the extent of 50 metres on the western border. The Bankura Rarh comprises of Damodar, Dwarakeswar Doab and Dawarakeswar Kasai tract. The river valleys are low lands but the doab lands are comparatively high. The physiographic features including population figures of these two districts are given in Table 1.

Climate :

The rolling uplands of Puruliya district experience an extreme climate with high range of temperature. The climate of these two districts is characterised by oppressive heat in summer and high humidity nearly all the year round. During summer the average daily maximum temperature varies between 26°C and 39°C and that during winter between 12°C and 25°C. Rainfall is scanty even though comparatively good rainfall occur on the eastern part of the district. Winter is dry. The Rarh plain of Bankura district in summer is humid and warm, while the winter is dry and cold. The annual average rainfall range between 130 cm and 140 cm. The average winter temperature is 15°C and the average summer temperature is about 30°C. Unlike Puruliya district, the annual range of temperature is not so high in Bankura district. Relative humidities are generally high throughout the year. Average percentage of humidity varies from 50 in April to 82 in August.

Soil :

Bankura district is the land of red soils belonging to old alluvial type. Pebble and sand predominate in these soils. The western part shows the presence of laterite soils. They are not suitable for agriculture and contain iron and lime, and very small quantity of humus. In general, the soils of Puruliya district are of laterite type, red in colour, unfertile and gravel-mixed, coarse textured, well-drained with low water holding capacity. Soils of Damodar and Kangsabati river banks are to some extent fertile (Roychaudhuri *et al.*, 1963).

Table 1. : Physiographical features of Bankura and Puruliya districts, West Bengal.

Parameters	Bankura district	Puruliya district
Area (in sq. km.)	6882	6259
Altitude	50–150 m	150–300 m
Latitude	22°38'–23°38' N	20°43'–23°12' N
Longitude	86°36'–87°46' E	85°49'–86°54' E
Highest hills	Susunia (440 m)	Chamta (699 m); Gorgaburu (677 m)
Population (2001 census)	31, 91, 822	25, 35, 233
Population density	464	405
Temperature (°C) Summer Winter	 26–38 15–24	 26–39 12–25
Rainfall	140 cm	137.5 cm
Humidity	50–82%	50–65%
Landscape type	Slightly undulating Rarh plains	Low hills, highlands and plateau
Soil type	Laterite—gravel mixed red soil	Western part—laterite Major part—old alluvial and sand mixed red soil
Vegetation type	Dry deciduous type (sal, mahua, palas, thorny shrub, palm, mango, etc.)	Dry deciduous type (predominated by sal, palas and mahua)
Gross cropped area (ha)	4,69,181	3,26,333
Forest cover (ha)	98,598	Reserve forest : 10,760 Protected forest : 56,264
Water resource (ha)	29,314.19	3,707.29

Note : Water resource includes areas of lentic and lotic waterbodies (rivers and canals). In case of Puruliya district this figure includes riverine area only. In Bankura district rivers and canals extend to 27,641.19 ha and lentic waterbodies spread over 1,673.00 ha.

Natural vegetation :

The natural vegetation of Rarh plain is dry deciduous type. Trees like sal, mahua and palas grow in the western part of Bankura district, while thorny shrubs, palm and mango trees are present throughout the rarh plain. In the uplands and plateau region of Puruliya district forest is widespread. But it is not so dense and the trees are generally of small height. They are deciduous and predominated by sal, mahua and palas.

The ponds, beels and bundhs, either natural or man-made, include wetland plants : (i) floating hydrophytes such as water hyacinth, water lettuce, duck weeds; (ii) suspended hydrophytes *viz.*, *Ceratophylum*; (iii) anchored hydrophytes *viz.*, *Nelumbo*, *Nymphaea*, *Nymphoides*, *Trapa*, *Vallisneria*, *Hydrilla*, *Ottelia*, *Najas*, *etc.*, and (iv) emergent amphibious hydrophytes like *Cyperus*, *Ipomoea*, *Marselia*, *Enhydra*, *Potamegeton*, *Paspalum*, *Aeschynomene*, *etc.*

Wetland profile :

The Damodar, the Dwarakeswar, the Silabati (Silai) and the Kangsabati (Kasai) are the four major rivers of Bankura and Puruliya districts. These rivers with their distributaries constitute the main drainage system of these two districts. All these rivers originate more or less within the western uplands of Puruliya district flow in south-southeast direction and fall in the Bay of Bengal. Though the summer dries up these rivers, the rains bring flood in almost all these rivers as their beds become elevated by deposition of pebbles, stones and sands. Both major and minor dams are constructed all over this region for irrigation purpose. The Directorate of Agricultural Engineering has commissioned 19 and 33 numbers of Surface Minor Irrigation Schemes in Bankura and Puruliya districts respectively. The Kangsabati dam (3,600 ha) is a major dam constructed on the river at Mukutmanipur of Bankura district in order to arrest flood and to provide irrigation facilities. Some wetlands named as Saheb bundhs are excavated as reservoirs water during British periods.

MATERIAL AND METHODS

During September 1998 and January-February, 2000, a total of 19 wetlands, 11 from Bankura district and 8 from Puruliya district (Table 2, Figs. 1 and 2), were surveyed for faunal inventory of wetlands of these two districts. It includes 3 dams, 1 daha and 15 bundhs from these two districts. Field observation, water quality analysis and collection of specimens (frogs, fishes, insects and other invertebrates including zooplankton) were made from these wetlands using a drag net and plankton net as well as hand picking. Higher vertebrates and cultivable fishes were observed in the field. Birds were counted by direct count method. Major faunal groups are listed in Tables 3–9 indicating the occurrence of species in specific wetlands under Bankura and Puruliya districts as numbered in Table 2. The collected specimens were identified by authors or in consultation with expert scientists of this department.

FAUNAL RESOURCE

The freshwater wetlands of Bankura and Puruliya districts are inhabited by a wide diversity of vertebrate and invertebrate faunal components. Only those species which are truly aquatic or those associated with or directly dependent upon the wetlands were included in the survey.

Table 2. : List of wetlands surveyed from Bankura and Puruliya districts, West Bengal.

Sl. No.	Name of wetland	Name of the nearest town / village	Approximate area (in ha)	Ecological category
	BANKURA DISTRICT			
1.	Ambikanagar Bundh	Gorabari	18	FW, SP, F
2.	Bagjobra Bundh	Gorabari	5.0	FW, SP, RR
3.	Jumuna Bundh	Bishnupur	25	FW, P, RR
4.	Kakila Daha	Kakila	4.4	FW, SP, RP
5.	Krishna Bundh	Bishnupur	25	FW, P, RR
6.	Kulaijurir Bundh	Bankadah	18	FW, SP, RR
7.	Lal Bundh	Bishnupur	12	FW, P, UR
8.	Rani Bundh	Sonamukhi	3.0	FW, SP, RR
9.	Saheb Bundh	Khatra	2.2	FW, SP, RR
10.	Sarenga Bundh	Ranibundh	1.4	FW, T, RR
11.	Sutan Dam	Ranibundh	6.5	FW, P, RR
	PURULIYA DISTRICT			
12.	Birshar Bundh	Dubra	1.5	FW, P, RR
13.	Chhatni Dam	Ajodhya	2.5	FW, P, UR
14.	Datta Bundh	Santaldih	4.0	FW, P, UR
15.	Hatinada Dam	Ajodhya	0.7	FW, SP, RR
16.	Indra Beel	Indrabeel	80	FW, P, OL
17.	Rani Bundh	Joypur	15	FW, SP, RR
18.	Saheb Bundh	Adra	50	FW, P, UR
19.	Saheb Bundh	Puruliya	30	FW, P, UR

Abbreviations : FW = Freshwater; P = Permanent wetland; SP = Semi-permanent wetland; T = Temporary wetland; F = Fishery; OL = Oxbow lake; RR = Rural reservoir; UR = Urban reservoir; RP = Rural pond.

Note : 1. A number of freshwater reservoirs in these two districts are named as Saheb Bundh as these waterbodies were excavated during British period under the augies of some Britishers ruling the area. However, Saheb Bundh of Adra is also well known as Adra reservoir or Adra Lake.

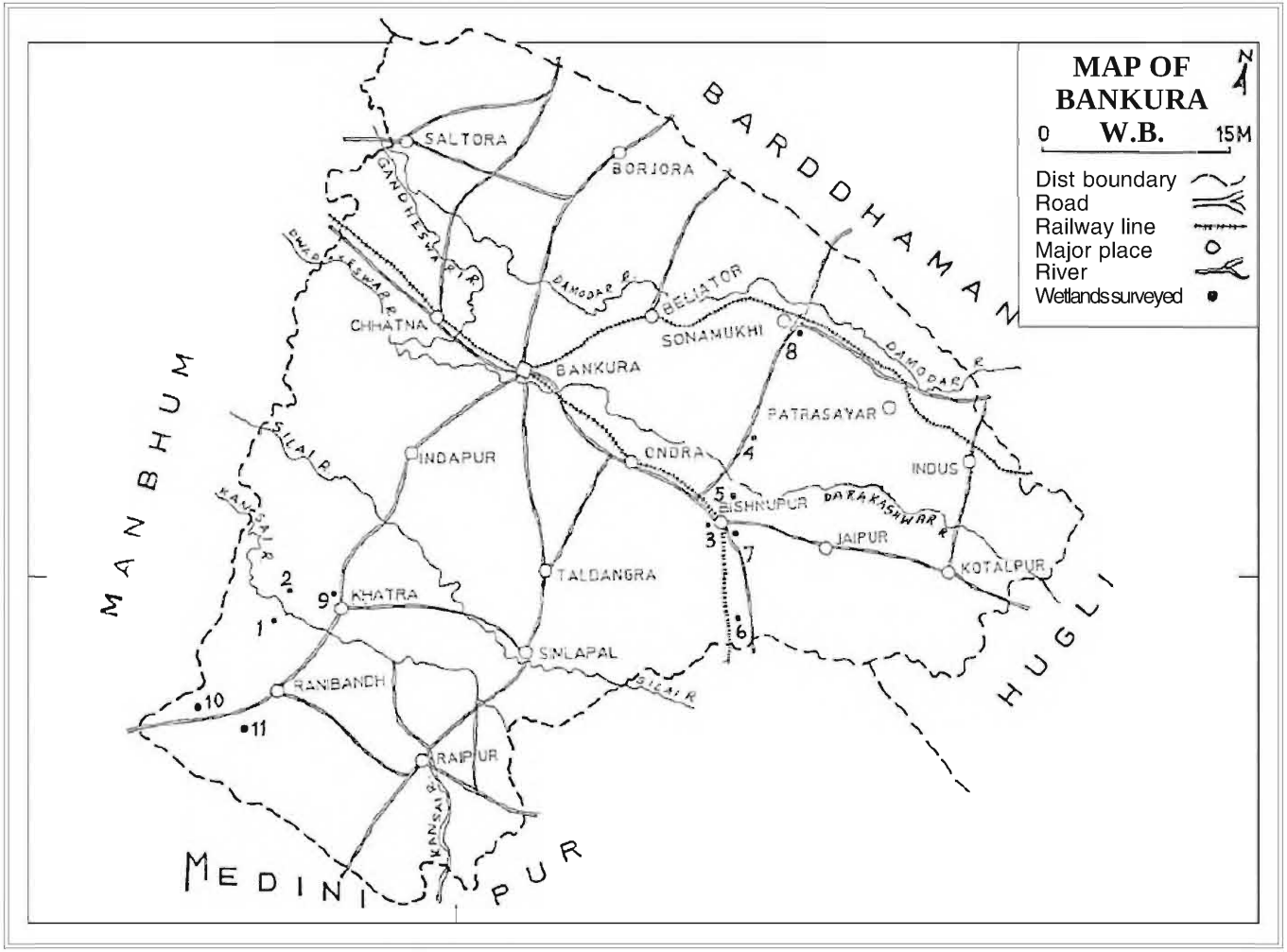

Fig. 1. : Map of Bankura district showing wetlands (1–11) surveyed. 1 = Ambikanagar Bundh; 2 = Bagjobra Bundh; 3 = Jamuna Bundh; 4 = Kakila Daha; 5 = Krishna Bundh; 6 = Kulaijurir Bundh; 7 = Lal Bundh; 8 = Rani Bundh; 9 = Saheb Bundh (Khatra); 10 = Sarenga Bundh; 11 = Sutan Dam.

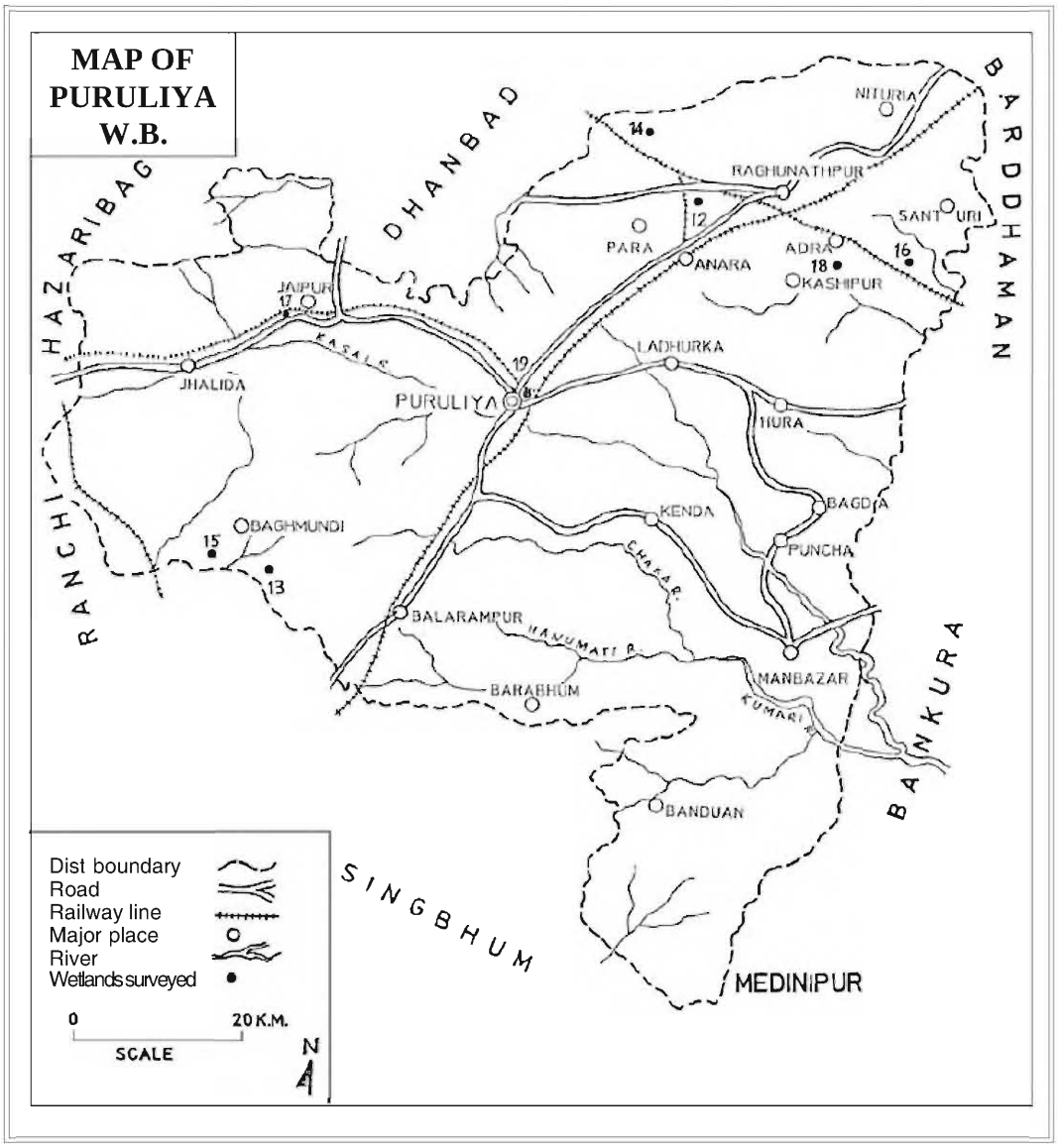

Fig. 2. : Map of Puruliya district showing wetlands (12–19) surveyed.

12 = Birshar Bundh; 13 = Chhatni Dam; 14 = Datta Bundh;
15 = Hatinada Dam; 16 = Indra Beel; 17 = Rani Bundh;
18 = Saheb Bundh (Adra); 19 = Saheb Bundh (Puruliya).

VERTEBRATES

***Mammals* :**

Aquatic or wetland dependent mammals could not be observed in and around wetlands surveyed from these two districts. However, the occurrence of Common Otter, *Lutra lutra* was reported earlier from Bankura district (Banerjee, 1968). The associated dryland species occurring around wetland habitats and adjoining forests of these two districts are Asiatic Jackal (*Canis aureus*), Bengal Fox (*Vulpes bengalensis*), Small Indian Civet (*Viverricula indica*), Palm Civet (*Paradoxurus hermaphroditus*), Jungle Cat (*Felis chaus*), Leopard Cat (*Felis bengalensis*), Leopard (*Panthera pardus*), Rhesus Macaque (*Macaca mulatta*), Hanuman Langur (*Presbytes entellus*), Indian Pangolin (*Manis crassicaudata*), Wolf (*Canis lapus*), Small Indian Mongoose (*Herpestes auropunctatus*), Indian Grey Mongoose (*Herpestes edwardsi*), Hyaena (*Hyaena hyaena*), Indian Elephant (*Elephas maximus*), Wild Boar (*Sus scrofa*), Spotted Deer (*Axis axis*, mainly in the parks around Adra and Kangsabati resorvoirs), Rufous-tailed Hare (*Lepus nigricollis*), Indian Crested Porcupine (*Hystrix indica*), Lesser Bandicoot Rat (*Bandicota bengalensis*) and Five-striped Squirrel (*Funambulus pennanti*) (O'Malley, 1908; Bhattacharya *et al.*, 1985; Banerjee, 1968; Agarwal *et al.*, 1992). These terrestrial mammalian species are listed herein to indicate the overall ecology of the area surrounding the wetlands of these two districts.

***Birds* :**

A total of 41 species of resident and migratory birds belonging to 10 families comprising of water birds, marsh birds and kingfishers have been encountered in the wetlands of these two districts (Table 3 & 4). Besides general faunistic study, a mid-winter waterbirds survey was conducted in eight selected wetlands of these two districts. These waterbirds were comprised of 34 species representing 11 resident (R), 12 resident migrant (RM) and 9 migrant (M) species (Table 4). All these migrant species representing ducks and geese were recorded from Puruliya district only. Large flocks of Lesser Whistling Teal, a resident anatid duck, *Dendrocygna javanica*, were, however, observed in both the districts, specially in Jamuna bundh and Krishna bundh of Bishnupur in Bankura district and also in both the Saheb bundhs of Adra and Puruliya proper of Puruliya district. During mid-winter survey the highest diversity of waterbirds (29 species) was recorded in Saheb bundh, Adra of Puruliya district. In an inventory of waterbirds from Saheb bundh of Puruliya town, NEWS (1998) reported 24 species without any count data. The higher diversity of wetland birds in Saheb bundh, Adra (*i.e.*, Adra reservoir) may be related to size, safe-refuge, availability of food and suitability of habitat concerned and also for its location along migratory pathways of the migrant species. It is worth mentioning that as per Asian Waterfowl Census 1994–1996, Lopez and Mundkur (1997) reported the occurrence of 22,274 birds in 1996 at Kangsabati Dam of Bankura district. Despite lacking any legal protection Kangsabati reservoir of Bankura district qualifies for designating it as a site of international importance (Ramsar Site) for hosting more than 20,000 waterfowl.

***Reptiles* :**

So far, four species of reptiles belonging to three families comprising of one species of pond turtle (*Lissemys punctata*), one species of monitor lizard (*Varanus bengalensis*) and two species of colubrid snakes (*Enhydris enhydris* and *Xenochrophis piscator*) have been recorded from wetlands of Bankura and Puruliya districts (Table 5).

***Amphibians* :**

Eight species of toads and frogs belonging to three families have been recorded (Table 6) from wetlands of these two districts. Of these, three ranid frogs *viz.*, *Rana cyanophlyctes*, *R. tigerina* and *Lemnectes limnocharis*, are more or less common in these two districts in and around waterbodies and also in roadside ditches. The bufonid and microhylid species are encountered mainly from moist shady places around wetlands. However, amphibian species are least explored from this part of West Bengal (Sarkar *et al.*, 1992).

***Fishes* :**

A total of 42 species belonging to 17 families have been recorded from various wetlands of Bankura and Puruliya districts (Table 7). Of the 17 families, the Family Cyprinidae is represented by 17 species including Indian major and minor carps (*Labeo*, *Catla* and *Cirrhinus*) and weed fishes (*Puntius*, *Esomus*, etc.). Some catfishes belonging to the genera *Clarias*, *Heteropneustes*, *Wallago*, *Mystus*, *Ompak* as well as murrels (*Channa* species) and mud eels (*Mastacembelus* and *Monopterus* species) are quite common in occurrence in wetlands of these two districts. Fish fauna in wetlands of these two districts have not been documented so far (Sen, 1992).

INVERTEBRATES

The aquatic invertebrate faunal elements comprising 84 species of macroinvertebrates and 36 species of zooplankton (Table 8 & 9) are reported herein mainly based on the specimens collected from the selected wetlands of Bankura and Puruliya districts. Macroinvertebrates belonging to five major groups, *viz.*, macrocrustaceans, insects, arachnids, annelids and molluscs, and zooplankton comprising of Copepoda, Ostracoda, Cladocera, Conchostraca and Rotifera have been recorded. It may be mentioned that Pattanayak (1999) reported 3 species of freshwater sponges from these two districts.

***Macrocrustaceans* :**

Seven species of macrocrustaceans comprising of 5 species of prawns and 2 species of crabs belonging to two families have been recorded from wetlands of Bankura and Puruliya districts. A perusal of literature indicates that prawns and crabs remain unexplored from region.

***Insects* :**

A total of 54 species of insects belonging to 6 orders and 17 families have been observed/ obtained from wetlands of these two districts. Among these, 47 species of aquatic adult insects belong to the orders Hemiptera (27 species) and Coleoptera (20 species), 5 species of aquatic larval forms representing orders Odonata (3 species) and Diptera (2 species), one species of ephemeropteran nymphs and a single species of wetland associated gryllotalpid, *Gryllotalpa africana* (Order Orthoptera) have been recorded. Of the six insect orders, Hemiptera represents the highest diversity of 27 species, followed by Coleoptera (20 species) and Odonata (3 species).

As per records, in the State Fauna of West Bengal, it is revealed that aquatic hemipterans and coleopterans are not thoroughly explored from Bankura and Puruliya districts (Bal and Basu, 1994a, b; Biswas *et al.*, 1955a, b, c). Bal and Basu (1994a, b) reported a total of 7 species of aquatic and semi-aquatic Hemiptera *viz.*, *Ptilomera laticauda* (Hardwicke), *Limogonus nitidus* (Mayr), *L. parvulus* (Stal), *Gerris adelaidis* Dohrn, *Diplonychus annulatum* (Fabricius), *D. rusticum* (Fabricius) and *Lethocercus indicus* (Lepeletier and Serville) from Bankura and Puruliya districts, while in the present paper 27 species have been encountered from some selected wetlands of these two districts. Biswas *et al.*, (1995a) recorded 10 species of dytiscid coleopterans such as *Laccophilus chinensis inefficiens* Walker, *Hydrovatus fusculus* Sharp, *Hyphoprus asper* Sharp, *Peschetius quadricostaius* (Aube), *Eretes sticticus* (Linnaeus), *Hydaticus* (*Guidnotites*) *fabricii* Macleay, *Hydaticus* (*Guidnotites*) *luczonicus* Aube, *Cybister* (*Meganectes*) *Confusus* Sharp, *Cybister (Meganectes) limbatus* (Fabricius) and *Cybister (Meganectes) ventralis* Sharp from Puruliya district only. In another paper, Biswas *et al.*, (1995c) recorded 2 species of hydrophilid coleopterans *viz.*, *Sphaeridium cameroni* d'Orchymont and *Sternolophus rufipes* (Fabricius) only from Puruliya district.

Chaudhuri and Chattopadhyay (1997) recorded some chironomid species such as *Clinotanypus fuscosiqnetus* (Kieffer), *C. novempunctatus* (Kieffer), *C. vomerus* Chaudhuri and Debnath, *Tanypus bilibatus* (Kieffer), *Eukiefferiella oryza* Chattopadhyay and Chaudhuri, *Chironomus javanus* Kieffer, *Kiefferulus incerdus* Chattopadhyay *et al.*, and *Polypedilum annulatipes* Kieffer from this region. Srivastava (1993) reported 4 species of Ephemeroptera *viz.*, *Cloeon bengalensis*, *Cloeon bicolor*, *Cleon kimminsi*, *Caenis perusilla*, from these two districts. Srivastava and Sinha (1993) recorded 26 species of adult Odonata from these two districts.

***Arachnids* :**

Three species of spiders belonging to three genera and two families, and one undetermined species of water mites were found to be associated/inhabited in wetlands of Bankura and Puruliya districts. These three genera of spider fauna *viz.*, *Lycosa*, *Pardosa* and *Tetragnatha* are reported from this region (Biswas and Biswas, 1992).

***Annelids* :**

Three species of annelids comprising of one species of freshwater oligochaete, *Limnodrilus* sp. and two species of aquatic leeches, viz., *Hellobdella nociva* and *Glossiphonia* sp. have been recorded from wetlands of Bankura and Puruliya districts. However, Mukhopadhyay (1999) reported 12 species of freshwater oligochaetes and Ghosh (1999) recorded 9 species of leeches from these two districts.

***Molluscs* :**

Twelve species of gastropod and 4 species of bivalve molluscs belonging to 9 families have been observed from freshwater wetlands of Bankura and Puruliya districts (Table 8). However, Thakur *et al.*, (1992) recorded 10 species of freshwater gastropod molluscs, *viz., Bellamya bengalensis, Bellamya dissimilis, Digoniostoma pulchella, Gobbia orcula, Thiara tuberculata, Thiara granifera, Lymnaea acuminata, Lymnaea luteola, Indoplanorbis exustus, Gyraulus convexiusculus* and 8 species of bivalve molluscs *viz., Lamellidens corrianus, Lamellidens marginalis, Parreysia corrugata, Parreysia favidens, Parreysia rajahensis, Parreysia sikkimensis, Parreysia caerulea* and *Corbicula striatella* from these two districts. Most of the wetlands of these two districts are dominated by thiarid gastropod species particularly in areas with sandy substratum.

***Zooplankton* :**

Thirtysix species of zooplankton belonging to Copepoda, Ostracoda, Cladocera, Conchostraca and Rotifera have been recorded from freshwater wetlands of Bankura and Puruliya districts (Table 9). Of these, cladocerans are represented by 27 species, ostracods by two species and three species each of copepods and rotifers, while one species *viz., Cyclestheria* sp. belongs to Conchostraca. Of the five different groups of zooplankton, cladocerans represent highest diversity of species inhabiting littoral vegetation. It is mentioned that Sharma (1999) reported 129 species of rotifers from West Bengal of which 28 species *viz., Branchionus angularis, B. budapestiensis, B. falcatus, Euchlanis dilata, Dipleuchlanis propatula, Colurella obtusa, Lepadella acuminata, L. ovalis, L. patella, L. triptera, Lecane aculeata, L. crepida, L. hornemanni, L. luna, L. papuana, L. inopinata, L. lunaris, L. quadridentata, L. sinuata, Cephalodella mucronata, Trichocerca pusilla, Asplanchna brightwelli, Dicranophorus forcipatus, Hexarthra mira, Pompholyx sulcata, Testudinella patina, Filinia longiseta* and *F. opoliensis* were recorded from Bankura district only and no collection was made by him from Puruliya district. Chandrasekhar (2004) reported thirteen species and subspecies of cladocean zooplankton from Adra Lake in Puruliya district, *viz., Diaphanosoma excisum, Moina brachiata, Bosmina longirostris, Macrothrix spinosa, Echinisca triserialis, Chydorus sphaericus, Chydorus parvus, Chydorus barroisi, Alona quadrangularis, Alona rectangula rectangula, Alona rectantula richardi* and *Acropus harpae,* and also stated that Adra Lake water is becoming mesotrophic and can not be directly used as drinking water.

Table 3. : List of birds recorded in wetlands of Bankura and Puruliya districts, West Bengal.

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
A. Resident birds (including resident migratory birds)		
Family PODICEPETIDAE		
Tachybaptus ruficollis (Pallas)	(3, 5–9, 11)	(16–19)
Family PHALACROCORACIDAE		
Anhinga rufa (Daudin)	(3, 5, 7, 9)	(16, 18)
Phalacrocorax carbo (Linnaeus)	(1, 3, 6)	(–)
Phalacrocorax fusicollis Stephens	(3, 11)	(18)
Phalacrocorax niger (Vieillot)	(1–11)	(12–19)
Family ARDEIDAE		
Ardea alba J.E. Gray	(1, 3, 6, 10)	(16, 18)
Ardea cinerea Linnaeus	(5, 6)	(–)
Ardeola grayii (Sykes)	(1–10)	(12–19)
Ardea purpurea Linnaeus	(3, 5–7)	(16, 18, 19)
Bubulcus ibis (Boddaert)	(1–11)	(12–19)
Egretta garzetta (Linnaeus)	(1–9)	(12, 14, 16, 18, 19)
Egretta intermedia (Wagler)	(1–11)	(12–19)
Ixobrychus cinnamomeus (Gmelin)	(1, 3, 5, 6)	(12, 18, 19)
Family CICONIIDAE		
Anastomus oscitans (Boddaert)	(3, 5, 6)	(16, 17)
Family RALLIDAE		
Amaurornis phoenicurus (Pennant)	(1–6, 9, 10)	(12, 13, 18, 19)
Fulica atra Linnaeus	(1, 6, 11)	(16, 18, 19)
Gallicrex cinerea (Gmelin)	(3, 5)	(18, 19)
Gallinula chloropus (Linnaeus)	(2, 3, 5, 7)	(18, 19)
Porphyrio porphyrio (Linnaeus)	(1–3, 5)	(12, 18, 19)
Family JACANIDAE		
Hydrophasianus chirurgus (Scopoli)	(2, 3, 5)	(12)
Metapidius indicus (Latham)	(1–3, 5)	(12, 16–19)

Table 3. : *(Cont'd.)*.

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family ROSTRATULIDAE		
Rostratula bengalensis (Linnaeus)	(1, 3, 5)	(16, 18)
Family CHARADRIIDAE		
Hoplopterus indicus (Boddaert)	(5)	(–)
Tringa nebularia (Gunnerus)	(–)	(16, 18, 19)
Vanellus malabaricus (Boddaert)	(–)	(16, 17)
Family ALCEDINIDAE		
Alcedo atthis (Linnaeus)	(1–3, 5–7, 9)	(13, 14, 18,19)
Ceryle rudis (Linnaeus)	(1, 3, 5, 7)	(13, 16, 18)
Halcyon smyrnensis (Linnaeus)	(1–3, 5–7)	(16, 18, 19)
Pelargopsis capensis (Linnaeus)	(1)	(16)
Family ANATIDAE		
Dendrocygna javanica (Horsfield) (R)	(3, 5, 6, 11)	(16–19)
Nettapus coromandelianus (Gmelin) (R)	(1–7, 11)	(12–14, 16–19)
Sarkidiornis melanotos (Pennant) (R)	(–)	(19)
B. Migratory birds		
Family ANATIDAE		
Anas acuta Linnaeus (M)	(–)	(16, 18, 19)
Anas crecca Linnaeus (M)	(–)	(16–19)
Anas penelope Linnaeus (M)	(–)	(18, 19)
Anas querquedula (M)	(–)	(16, 18)
Anser anser (Linnaeus) (M)	(–)	(16)
Aythya ferina (Linnaeus) (M)	(–)	(16, 18)
Aythya fuligula (Linnaeus) (M)	(–)	(17)
Netta rufina (Pallas) (M)	(–)	(16, 18, 19)

Table 4. : Mid winter count data of waterbirds in some selected wetlands of Bankura and Puruliya districts, West Bengal.

SL. No.	English name	Scientific name	Number of birds counted in wetlands of							
			Bankura district				Puruliya district			
			JB	KB	LB	KJB	SBP	SBA	RB	IB
		A. WATERFOWL								
		Order PODICIPEDIFORMES								
		Family PODICIPEDIDAE								
1.	Little Grebe,	*Tachybaptus ruficollis* (R)	25	7	31	16	86	48	28	49
		Order PELECANIFORMES								
		Family PHALACROCORACIDAE								
2.	Cormorant,	*Phalacrocorax carbo* (R)	1	–	–	2	–	–	–	–
3.	Indian Shag,	*Phalacrocorax fuscicollis* (RM)	1	–	–	–	–	2	–	–
4.	Little Cornorant,	*Phalacrocorax niger* (RM)	21	15	18	10	12	32	2	60
5.	Darter,	*Anhinga rufa* (RM)	2	1	1	–	–	1	–	1
		Order CICONIFORMES								
		Family ARDEIDAE								
6.	Grey Heron,	*Ardea cinerea* (RM)	–	1	–	–	–	–	–	–
7.	Purple Heron,	*Ardea purpurea* (RM)	3	4	–	2	1	5	–	6
8.	Pond Heron,	*Ardeola grayi* (R)	12	6	2	5	8	3	2	5
9.	Cattle Egert,	*Bubulcus ibis* (RM)	18	3	6	2	8	4	9	3
10.	Larger Egert,	*Ardea alba* (RM)	6	2	–	–	–	2	–	3
11.	Smaller Egret,	*Egretta intermedia* (RM)	4	2	2	1	–	–	5	2
12.	Little Egret,	*Egretta garzetta* (R)	3	9	5	1	5	16	–	11
13.	Chestnut Bittern,	*Ixobrychus cinnamomeus* (RM)	2	1	–	1	18	3	–	–
		Family ANATIDAE								
14.	Greylag Geese,	*Anser anser* (M)	–	–	–	–	–	–	–	4
15.	Pintail,	*Anas acuta* (M)	–	–	–	–	89	26	–	7
16.	Common Teal,	*Anas crecca* (M)	–	–	–	–	74	85	10	6
17.	Gadwall,	*Anas strepera* (M)	–	–	–	–	–	11	–	6

Table 4. : *(Cont'd.).*

SL. No.	English name	Scientific name	Number of birds counted in wetlands of							
			Bankura district				Puruliya district			
			JB	KB	LB	KJB	SBP	SBA	RB	IB
18.	Wigeon,	*Anas penelope* (M)	–	–	–	–	53	15	–	–
19.	Garganey,	*Anas querquedula* (M)	–	–	–	–	10	7	–	4
20.	Common Pochard,	*Aythya ferina* (M)	–	–	–	–	–	14	–	8
21.	Tufted Pochard,	*Aythya fuligula* (M)	–	–	–	–	–	–	24	–
22.	Redcrested Pochard,	*Netta rufina* (M)	–	–	–	–	55	322*	–	21
23.	Cotton Teal,	*Nettapus coromandelianus* (R)	50	27	15	17	69	71	15	13
24.	Lesser Whistling Teal,	*Dendrocygna javanica* (R)	1520*	255	–	55	2500*	3504*	67	71
25.	Comb Duck,	*Sarkidiornis melanotos* (R)	–	–	–	–	47	–	–	–
	Order GRUIFORMES									
	Family RALLIDAE									
26.	Whitebreasted Waterhen,	*Amaurornis phoenicurus* (R)	5	8	–	3	4	2	–	–
27.	Indian Mooreehen,	*Gallinula chloropus* (RM)	9	8	11	–	103	22	–	–
28.	Purple Moorehen,	*Porphyrio porphyrio* (R)	16	11	–	–	72	14	–	–
29.	Coot,	*Fulica atra* (RM)	–	–	–	4	7	115	–	10
30.	Watercock,	*Galicrex cinerea* (R)	4	7	–	–	–	–	–	–
	Order CHADRIIFORMES									
	Family JACANIDAE									
31.	Pheasant-tailed Jacana,	*Hydrophasianus chirurgus* (R)	2	2	–	–	–	–	–	–
32.	Bronzewinged Jacana,	*Metapidius indicus* (R)	75	24	–	–	24	13	6	2
	B. WADERS									
	Order CHARADRIIFORMES									
	Family CHARADRIIDAE									
33.	Yellow Wattled Lapwing,	*Venellus malabaricus* (R)	–	–	–	–	–	–	1	1
34.	Green Shank,	*Tringa nebularia* (M)	–	–	–	–	2	12	–	4

Note : R = Resident, RM = Resident migrant < M = Migrant, * = Not representing total count, JB = Jamuna bundh, KB = Krishna bundh, LB = Lal bundh, KJB = Kulaijurir bundh, SBP = Saheb bundh, Puruliya, SBA = Saheb bundh, Adra, RB = Rani bundh, IB = Indra beel.

Table 5. : List of reptilian species occurring in wetlands of Bankura and Puruliya districts.

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family TRIONYCHIDAE		
Lissemys punctata (Bonaterre) Indian Flap-shelled Turtle	(1–3, 5–7)	(14, 17–19)
Family VARANIDAE		
Varanus bengalensis (Daudin) Bengal Monitor	(2, 3)	(18)
Family COLUBRIDAE		
Enhydris enhydris (Schneider) Smooth Water Snake	(1–10)	(16–19)
Xenochrophis piscator Checkered Keelback	(1–11)	(12–19)

Table 6. : List of amphibian species occurring in wetlands of Bankura and Puruliya districts.

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family BUFONIDAE		
Bufo melanostictus Schneider Common Indian Toad	(1–11)	(14, 16–19)
Bufo stomaticus Lutken Marbled Toad	(2, 5)	(–)
Family MICROHYLIDAE		
Microhyla ornata (Dumeril and Bibron) Ornate Frog	(1, 5, 10)	(14, 18, 19)
Kaloula pulchra Gray Painted Frog	(2)	(14)
Family RANIDAE		
Rana crassa Jerdon Jerdon's Bull Frog	(6)	(–)
Euphlyctis cyanophlyctis Schneider Skipping Frog	(1–11)	(12–19)
Limnonectes limnocharis Boie Cricket Frog	(1–9)	(12, 16–19)
Rana tigerina Daudin Indian Bull Frog	(1–8)	(12–19)

Table 7. : List of fishes occurring in wetlands of Bankura and Puruliya districts.

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family NOTOPTERIDAE		
Notopterus notopterus (Pallas)	(1, 2, 5–9)	(14–19)
Family CYPRINIDAE		
Salmostoma bacaila (Hamilton)	(1, 3, 5–11)	(14, 16–19)
Hypophthalamichthys molitrix (Valenciennes)	(1, 3–9)	(14, 17–19)
Amblypharyngodon mola (Hamilton)	(1–11)	(12–19)
Esomus danrica (Hamilton)	(1–11)	(12–19)
Rasbora daniconius (Hamilton)	(1–11)	(12–19)
Catla catla (Hamilton)	(1, 3, 5–11)	(13–19)
Cirrhinus mrigala (Hamilton)	(1, 3, 5–11)	(13–19)
Cyprinus carpio Linnaeus	(1, 3, 5–9)	(14, 16–19)
Ctenopharyngodon idella (Valenciennes)	(1, 3, 5–9)	(14, 16–19)
Labeo bata (Hamilton)	(1, 3, 5–9)	(14, 16–19)
Labeo calbasu (Hamilton)	(1, 3, 5–11)	(13–19)
Labio rohita (Hamilton)	(1, 3, 5–11)	(13–19)
Puntius chola (Hamilton)	(1–7)	(12, 18, 19)
Puntius conchonius (Hamilton)	(1–7)	(12, 18, 19)
Puntius phutunio (Hamilton)	(1–7)	(12, 18, 19)
Puntius sophore (Hamilton)	(1, 3, 5–9)	(14, 17–19)
Puntius ticto (Hamilton)	(1–11)	(12–19)
Family COBITIDAE		
Lepidocephalus guntea (Hamilton)	(1–3, 5–10)	(15–19)
Family BAGRIDAE		
Mystus vittatus (Bloch)	(1–9)	(14–19)
Mystus tengara (Hamilton)	(1, 3, 5)	(14, 16–19)
Family SILURIDAE		
Ompak bimaculatus (Bloch)	(1, 3, 11)	(16)
Wallago attu (Schneider)	(2, 5, 6)	(12, 15, 16, 19, 19)
Family CLARIIDAE		
Clarias batrachus (Linnaeus)	(1–11)	(12–19)

Table 7. : *(Cont'd.).*

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family HETEROPNEUSTIDAE		
Heteropneustes fossilis (Bloch)	(1–11)	(12–19)
Family CYPRINODONTIDAE		
Aplocheilus panchax (Hamilton)	(1–11)	(12–19)
Family CHANNIDAE		
Channa striatus (Bloch)	(1–11)	(12–19)
Channa orientalis (Schneider)	(1–11)	(12–19)
Channa punctatus (Bloch)	(1–11)	(12–19)
Family SYMBRANCHIDAE		
Monopterus cuchia (Hamilton)	(1–11)	(12–19)
Family CHANDIDAE		
Chanda nama Hamilton	(1, 3, 5–11)	(12–19)
Chanda ranga Hamiton	(1–11)	(12–19)
Family GOBIIDAE		
Glossogobius giuris (Hamilton)	(1–11)	(12–19)
Oligolepis acutipennis (C. V.)	(1, 3, 5–11)	(14–19)
Family NANDIDAE		
Badis badis (Hamilton)	(1–11)	(12–19)
Nandus nandus (Hamilton)	(1–11)	(12–19)
Family ANABANTIDAE		
Anabas testudineus (Bloch)	(1–11)	(12–19)
Family CICHLIDAE		
Oreochromis mossambica (Peters)	(1, 3, 5–9)	(14, 18, 19)
Family BELONTIDAE		
Colisa fasciatus (Schneider)	(1–11)	(12–19)
Family MASTACEMBELIDAE		
Macronathus aculeatus (Bloch)	(1–11)	(12–19)
Mastacembelus armatus (Lacepede)	(1, 3, 5–9)	(14, 16–19)
Mastacembelus pancalus (Hamilton)	(1–11)	(12–19)

Table 8. : List of macroinvertebrates recorded in wetlands of Bankura and Puruliya districts, West Bengal.

Family and species	Occurrence in wetlands of	
	Barıkura district	**Puruliya district**
Macrocrustaceans (Decapoda)		
Family PALAEMONIDAE		
Macrobrachium rosenbergii (deMan)	(1, 5, 11)	(16, 18, 19)
Macrobrachium lamarrei (H.M. Edwards)	(1–3, 5, 6, 11)	(16, 18, 19)
Macrobrachium sp.	(1–3, 5–11)	(13, 14, 16–19)
Palaemon styliferus Milne Edwards	(1–3, 5, 6, 11)	(14, 16, 18, 19)
Family ATYIDAE		
Caridina sp.	(1–11)	(12–19)
Family POTAMONIDAE		
Sartoriana spinigera Wood Masoon	(1, 5, 6)	(18, 19)
Paratelphusa hydrodromus Herbst	(1, 3–6)	(13, 17–19)
Insects		
INSECTA HEMIPTERA		
Family BELOSTOMIDAE		
Diplonychus rusticum (Fabricius)	(2, 11)	(–)
Diplonychus annulatus (Fabricius)	(1–11)	(12, 16–19)
Diplonychus sp.	(1, 2, 4, 10)	(12, 14, 15, 18, 19)
Lethocercus indicus (Lep. & Serv.)	(2–4)	(12)
Family NEPIDAE		
Laccotrephes elongatus Montadon	(1, 6)	(15, 19)
Laccotrephes sp.	(1)	(12, 13, 16)
Ranatra sordidula Dohrn	(6, 10)	(18, 19)
Ranatra filiformis Fabricius	(1–5, 9, 11)	(12, 17–19)
Ranatra varipes Stal	(6)	(18)
Ranatra sp.	(1–4, 7–11)	(12–16, 19)
Family CORIXIDAE		
Corixa spp. (2 species)	(1, 2, 10)	(12, 17)
Micronecta merope	(2)	(–)
Micronecta sp.	(1–4, 8)	(12, 16–19)
Family NOTONECTIDAE		
Anisops breddini Krikaldy	(1, 6, 8, 10)	(13, 14, 17)
Anisops barbata Krikaldy	(1, 6)	(–)
Anisops sp.	(1–11)	(12–19)

Table 8. : *(Cont'd.).*

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family MESOVELIDAE		
Mesovelia vittigera Horvatch	(2, 11)	(–)
Mesovelia sp.	(2–4)	(12)
Family HYDROMETRIDAE		
Hydrometra greeni Kirkaldy	(1, 2, 4, 10)	(17)
Family GERRIDAE		
Gerris spinolae Leth. & Surv.	(–)	(14)
Gerris sp.	(1–3, 5–11)	(12–19)
Limnogonus parvulus (Stal)	(6)	(14)
Limnogonus sp.	(3, 9)	(15, 16)
Rhagadotarsus kraepelini Breddin	(2)	(14)
Family PLEIDAE		
Plea sp.	(1, 2, 4, 6, 9)	(19)
Family VELIIDAE		
Microvelia sp.	(2, 9)	(12, 17)
INSECTA COLEOPTERA		
Family DYTISCIDAE		
Canthydrus laetabilis (Walker)	(1–10)	(12, 16, 18, 19)
Canthydrus morsbachi (Wel.)	(2–4, 10)	(16, 19)
Canthydrus sp.	(1, 4, 9)	(12, 17, 18)
Cybister limbatus (Fabricius)	(4, 6)	(12)
Cybister sp.	(2, 4)	(19)
Hydrovatus sp.	(3, 8, 9)	(12)
Laccophilus anticatus Sharp	(1, 3, 5, 6)	(17)
Laccophilus sp.	(1–6, 9)	(19)
Hydrocoptus subvittulus Motschulsky	(1, 2, 4)	(18, 19)
Hydrocoptus sp.	(2–4, 7)	(12)
Family HYDROPHILIDAE		
Regimbartia attenuata Fabricius	(1–3, 10)	(12, 19)
Sternolophus rufipes Fabricius	(2–5, 8, 10)	(19)
Berosus indicus Motsculsky	(2, 7, 9)	(17)
Berosus sp.	(1–4, 8, 10)	(12)
Hydrophilus sp.	(1, 3–5)	(–)
Helochares sp.	(2, 4, 6, 9)	(18)
Amphiops sp.	(2)	(16, 18, 19)
Globeria sp.	(2–4)	(16, 18)

Table 8. : *(Cont'd.).*

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family GYRINIDAE		
Dineutes sp.	(1)	(–)
Family CURCULIONIDAE		
Bagous sp.	(1)	(–)
INSECTA ODONATA		
Family LIBELLULIDAE		
Urothemis sp.(1–3, 5, 10)	(12, 16, 18)	
Brachythemis sp.	(1–4, 9)	(16–19)
Family COENAGRIONIDAE		
Enallagma sp.	(1–4, 8–10)	(16–19)
INSECTA EPHEMEROPTERA		
Family BAETIDAE		
Cloeon sp.	(6)	(13, 16, 18)
INSECTA DIPTERA		
Family CULICIDAE		
Mosquito larvae	(1–5, 7)	(12, 14, 18, 19)
Family CHIRONOMIDAE		
Chironomid larvae	(1–4, 9, 10)	(12, 16–19)
INSECTA ORTHOPTERA		
Family GRYLLOTALPIDAE		
Gryllotalpa africana Beauvois	(1, 3, 4)	(16)
Arachnids		
Family LYCOSIDAE		
Lycosa sp.	(2, 10)	(–)
Pardosa sp.	(2, 4)	(12)
Family TETRAGNATHIDAE		
Tetragnatha sp.	(2, 4, 9)	(17)
Order ACARINA		
Water mites	(1–4, 8)	(12, 18)
Annelids		
Family TUBIFICIDAE		
Limnodrilus sp.	(1–4)	(12, 17, 18)

Table 8. : *(Cont'd.).*

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Family GLOSSIPHONIDAE		
Glossiphonia sp.	(2, 3, 5)	(15, 17)
Family RHYNCHOBDELLIDAE		
Hellobdela nociva Harding	(5, 10)	(–)
Molluscs		
MOLLUSCA GASTROPODA		
Family THIARIDAE		
Thiara tuberculata (Muller)	(1–3, 5, 6, 11)	(14, 16, 18, 19)
Thiara lineata (Gray)	(6, 11, 16)	(16)
Family VIVIPARIDAE		
Bellamya bengalensis (Lamarck)	(1–10)	(12, 14–19)
Bellamya dissimilis (Mueller)	(5, 6)	(15, 17, 18)
Family PILIDAE		
Pila globosa (Swainson)	(1–10)	(12, 13, 16–18)
Family BITHYNIDAE		
Digonistoma pulchella (Benson)	(1–10)	(13–19)
Gabbia orcula (Frauenfeld)	(3, 6)	(16, 18)
Family PLANORBIDAE		
Indoplanorbis exustus (Deshayes)	(1–10)	(12–19)
Gyraulus convexiusculus (Hutton)	(1–11)	(12, 14, 16–19)
Gyraulus labiatus (Benson)	(3, 6)	(16, 18)
Family LYMNAEIDAE		
Lymnaea acuminata Lamarck	(1–10)	(12–19)
Lymnaea luteola Lamarck	(1–5, 7–9)	(12, 17–19)
MOLLUSCA BIVALVIA		
Family UNIONIDAE		
Lamellidens corrianus (Lea)	(3, 6)	(16)
Lamellidens marginalis (Lamarck)	(5, 6, 9)	(12)
Family AMBLENIDAE		
Parreysia sp.	(6)	(14)
Family CORBICULIDAE		
Corbicula striatella Deshayes	(1, 5, 6)	(–)

Table 9. : List of zooplankton species occurring in wetlands of Bankura and Puruliya districts, West Bengal.

Family and species	Occurrence in wetlands of	
	Barıkura district	**Puruliya district**
CRUSTACEA : COPEPODA		
Family DIPTOMIDAE		
Diaptomus sp.	1–5, 7–9	12, 14, 18, 19
Heliodiaptomus sp.	1–5, 7–9	12, 14, 15, 18, 19
Family CYCLOPIDAE		
Mesocyclops sp.	1–5, 7–9	12, 14, 15, 18, 19
CRUSTACEA : OSTRACODA		
Family CYPRIDAE		
Cypris sp.	1–5, 7–9	12, 15, 18, 19
Stenocypris sp.	3, 4	12, 18
CRUSTACEA : CLADOCERA		
Family SIDIDAE		
Diaphanosoma excisum Sars	1–4, 8, 9	12, 15, 18, 19
Diaphanosoma sarsi Richard	1, 3–5, 7, 9	12, 14, 15, 19
Diaphanosoma sp.	1–4, 5, 7, 9	12, 18, 19
Latonopsis australis Sars	2–5, 7, 8	12, 18, 19
Pseudosida bidentata Herrick	2–4, 8	12, 14, 18, 19
Family DAPHNIIDAE		
Ceriodaphnia cornuta Sars	1, 3–5, 7, 9	12, 14, 18, 19
Simocephalus exspinosus (Koch)	1, 3–5, 7, 9	12, 18, 19
Simocephalus vetulus (O.F. Muller)	1, 9	12, 18
Simocephalus sp.	2–4, 8	14, 15, 19
Family MOINIDAE		
Moina sp.	2–5, 7, 8	14, 15
Family MACROTHRICIDAE		
Macrothrix spinosa King	1, 5, 7, 9	12, 14, 18
Macrothrix triserialis (Brady)	3, 4	12, 18
Macrothrix sp.	3, 4	12, 18
Ilyocryptus sp.	2, 8	14
Family CHYDORIDAE		
Alona costata Sars		2, 8 14
Alona davidi Richard	1, 3, 4, 9	12, 18, 19
Alona karua (King)	1, 3–5, 7, 9	14, 15
Alona pulchella Sars	1, 3, 4, 9	12, 14, 18, 19

Table 9. : *(Cont'd.).*

Family and species	Occurrence in wetlands of	
	Bankura district	**Puruliya district**
Alona rectangula Sars	2, 5, 7, 8	12, 18, 19
Alona sp.	3, 4	12, 18
Alonella excisa (Fischer)	1, 9	15
Chydorus barroisi (Richard)	2–4, 8	15
Chydorus reticulatus Daday	1, 3, 4, 9	14, 15
Chydorus sphaericus (O.F. Muller)	1, 3–5, 7, 9	12, 15, 18, 19
Dunhevedia crassa King	3, 4	19
Kurzia sp.	1, 3, 4, 9	12, 14, 15, 18
Pleuroxus similis Vavra	1, 9	12, 18
CRUSTACEA : CONCHOSTRACA		
Family CYCLESTHERIDAE		
Cyclestheria sp.	3, 4	12, 18, 19
ROTIFERA		
Family ASPLANCHIDAE		
Asplanchna sp.	1, 3–5, 7, 9	12, 14, 18, 19
Family BRACHIONIDAE		
Brachionus sp.	1, 2, 5, 7–9	12, 14, 18
Family FILINIDAE		
Filinia sp.	1–4, 8, 9	12, 15, 18, 19
Total (= 36 species)	**36**	**36**

CLUSTER ANALYSIS

Since the present paper is the fifth and probably the last instalment of the series on wetland faunal resources of West Bengal, it is felt to compare the degree of similarities amongst all these wetlands of different eco-regions using cluster analysis programme incorporating data from the other four papers in the series. For this purpose Sorensen's (1948) index of similarity is herein used as a basis of quantifying similarities between the faunal diversities of wetlands of different eco-regions. The index of similarity or quotient of similarity (Qs) between two samples as proposed by Sorensen (1948) is calculated as follows :

$$Q = \frac{2c}{a+b}$$

where, a = number of species in sample one,

b = number of species in sample two,

c = number of species common to both.

It measures the similarity in the species composition of the sample and the value of Qs ranges between 0 and 1. The value zero indicates complete dissimilarity, whereas the value 1 denotes maximum similarity between the samples (or faunal composition). The scores are multiplied by 100 to represent a percentage scale. Mountford's (1962) technique was followed to classify the percentage similarity values and for construction of dendrogram.

The faunal similarity index values between pairs of sampling sites (or eco-regions), showing the extent of affinities between the samples, have been analysed and presented in the form of dendrogram (Fig. 3). The dendrogram shows one prominent cluster (A) formed between the wetlands of Rarh plain of Bankura district (RP) with highland and plateau of Puruliya district (HP)

Faunal similarity index between pairs of sampling sites

	GP	DH	TD	RP	HP
CP	0.53	0.22	0.39	0.51	0.58
GP		0.23	0.44	0.54	0.54
DH			0.62	0.36	0.31
TD				0.60	0.52
RP					0.93

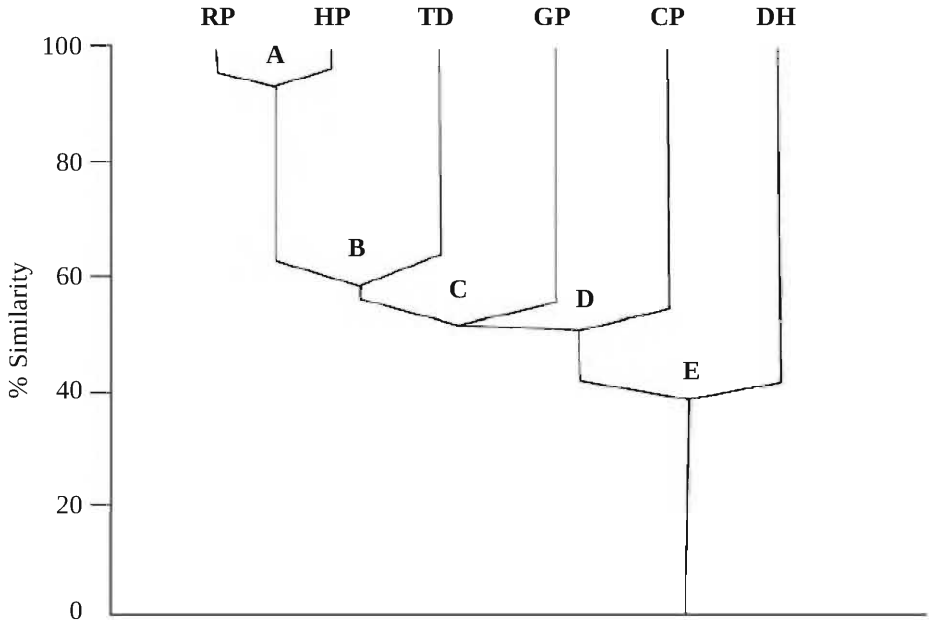

Fig. 3. : Dendrogram showing percentage similarity values of the six selected eco-regions of West Bengal.

(**Note :** CP = Coastal plain of North and South 24-Parganas districts; GP = Gangetic plain of Haora and Hugli districts; DH = Darjiling Himalaya of Darjiling district; TD = Terai Duars of Jalpaiguri district; RP = Rarh plain of Bankura district and HP = Highland and plateau of Puruliya district)

representing greatest similarity (93%) probably for their close proximity and similar climatic conditions and habitat types, followed by three intermediate clusters viz., cluster (B) between faunal elements of cluster A with that from wetlands of Terai Duars of Jalpaiguri district (TD); cluster (C) between cluster (B) with wetlands of Gangetic plain of Haora and Hugli districts (GP) and cluster (D) between cluster (C) with wetlands of Coastal plain of North and South 24-Parganas districts (CP), showing similarities of 58%, 51% and 50% respectively. The least similarity of 38% is revealed from cluster (E), which is formed between cluster D with wetlands of Darjiling Himalayas (DH) of Darjiling district. This may be due to cold climatic condition and dearth of diversified wetlands of this part of West Bengal.

UTILIZATION OF THE WETLANDS

The wetlands of Bankura and Puruliya districts are utilized in various ways. The worthwhile uses of eight selected wetlands of these two districts, four wetlands from each district, are shown in Table 10. Most of the wetlands of these two districts are used for irrigation purposes. Some important wetlands are excavated during preindependence period as reservoir of water. Both the Saheb bundhs of Adra and Puruliya town of Puruliya district have high recreational value. All these eight wetlands of these two districts (Table 10) are important waterfowl habitats, while all the four wetlands of Puruliya district are important migratory bird habitats as well.

Table 10. : Utilization scenario in important wetlands of Bankura and Puruliya districts, West Bengal.

	Name of district	**Bankura district**				**Puruliya district**			
	Name of wetland	**JB**	**KB**	**LB**	**KJB**	**SBP**	**SBA**	**RB**	**IB**
1.	Reservoir of water a) Domestic use	L	L	M	M	H	M	L	M
	b) Irrigation/agricultural use	M	M	L	H	M	H	H	H
2.	Waterfowl habitat	H	M	M	M	H	H	M	H
3.	Fisheries	L	L	M	M	M	M	L	M
4.	Tourism	L	L	L	L	H	H	L	L
5.	Nature conservation	M	M	M	M	H	H	M	M
6.	Recreation	M	M	M	M	H	H	L	L
7.	Flood control	H	M	M	H	M	M	M	H

Abbreviations :

1. Name of wetland : JB = Jamuna Bundh; KB = Krishna Bundh; LB = Lal Bundh; KJB = Kulaijurir Bundh; SBP = Saheb Bundh, Puruliya; SBA = Saheb Bundh, Adra; RB = Rani Bundh; IB = Indra Beel.
2. Wetland use value : H = High; M = Medium; L = Low.

DISCUSSION

The faunal diversity of the freshwater wetlands surveyed from Bankura and Puruliya districts represents a total of 215 species of 12 major groups. A comparison of the freshwater wetlands (Table 11) representing the coastal plains of North and South 24-Parganas districts, Gangetic plains of Haora and Hugli districts, and Hill and Terai Duars regions of Darjiling and Jalpaiguri districts reveals that these regions were inhabited by 235 species (Nandi *et al.*, 1993), 286 species (Nandi *et al.*, 1999) and 207 species (Nandi *et al.*, 2005) respectively. Among the two districts, wetlands of both Bankura and Puruliya districts are inhabited by 202 species, though representing variance in diversity of different groups. The variation in diversity of species among the two districts and also among the regions may be due to habitat ecology and water quality of wetlands and also due climatic condition of this region.

Table 11. : Faunal diversity (major groups) of freshwater wetlands of West Bengal representing coastal plains, Gangetic plains, Hills and Terai Duars as well as Rarh plains and highlands and plateaus.

Major groups	Faunal diversity of					
	Coastal plains	Gangetic plains	Hills and Terai Duars	Rarh plains (Bankura)	Highland and plateaus (Puruliya)	Total wet-land fauna of Bankura and Puru-liya district
Mammals	3	1	6	0	0	0
Birds	67	54	20	29	38	41
Reptiles	6	6	6	4	4	4
Amphibians	6	6	7	8	6	8
Fishes	56	48	54	42	42	42
Decapod crustaceans	7	7	7	7	7	7
Hemipterans	20	27	30	26	23	27
Coleopterans	24	35	11	20	17	20
Miscellaneous insects	–	–	12	7	7	7
Arachnids	8	6	6	4	3	4
Annelids	9	6	3	3	2	3
Molluscs	12	15	13	16	15	16
Zooplankton	17	55	45	36	36	36
Total	**235**	**286**	**220**	**202**	**202**	**215**

Habitat ecology of eight important wetlands of these two districts is depicted in Table 12. While surveying mid-winter water bird population of these two districts, Nandi *et al.*, (2004) suggested that the richness and diversity of waterbirds perhaps dependent on the size, availability of food and safe refuge of the wetlands. The richness and faunal diversity particularly macroinvertebrate and zooplankton species appear to be dependent on the habitat condition and macrophyte density and diversity of the wetlands. However, in general, the undulating highlands and plateau regions of Rarh plain of Bankura and Puruliya districts are faunistically very little explored and there is scope for further exploration.

Table 12. : Habitat ecology of eight important wetlands of Bankura and Puruliya districts, West Bengal.

Name of district	**Bankura district**				**Puruliya district**			
Name of wetland	**JB**	**KB**	**LB**	**KJB**	**SBP**	**SBA**	**RB**	**IB**
Nearest town/village	Bish-nupur	Bish-nupur	Bish-nupur	Ban-kadah	Puru-liya	Adra	Joypur	Indrabil
Locality type	Semi-Urban	Rural	Semi-Urban	Rural	Urban	Semi-Urban	Rural	Rural
Approximate area (ha)	25	45	12	18	30	50	15	80
Vegetation cover	70%	60%	50%	40%	80%	70%	50%	60%
Wetland use	M	L	M	H	H	H	M	M
Protection	M	L	M	L	H	H	Nil	L
Poaching	Rare	Rare	Rare	Rare	Nil	Nil	Low	High

Abbreviations :
1. Name of wetland : JB = Jamuna Bundh; KB = Krishna Bundh; LB = Lal Bundh; KJB = Kulaijurir Bundh; SBP = Saheb Bundh, Puruliya; SBA = Saheb Bundh, Adra; RB = Rani Bundh; IB = Indra Beel.
2. Wetland use value : H = High; M = Medium; L = Low.

SUMMARY

1. A faunal inventory of 19 freshwater wetlands comprising of 11 wetlands from Bankura district and 8 from Puruliya district dealing with a total of 215 species of wetland fauna belonging to 95 species of vertebrates and 84 species of macroinvertebrates and 36 species of zooplankton is communicated.
2. The vertebrate fauna comprises of 41, 4, 8 and 42 species of birds, reptiles, amphibians and fishes respectively, while invertebrate elements include 84 species of macroinvertibrates and 36 species of zooplankton.
3. Nine species of migratory anatid ducks are recorded from wetlands Puruliya district only.
4. The diversity of wetland fauna is discussed with reference to wetlands in different eco-regions of West Bengal.

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FRESHWATER PRAWN AND SHRIMP (CRUSTACEA : DECAPODA) DIVERSITY IN SINGAPERUMALKOIL PADDY FIELD NEAR CHENNAI

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Key words : Singaperumalkoil, Paddy field, Freshwater prawns, *Caridina*, *Macrobrachium*, diversity.

Collections of freshwater prawns and shrimps were made from a paddy field located in Singaperumalkoil near Chennai from April 1998 to March 2000, yielded ten species belonging to two families *viz.*, Palaemonidae and Atyidae. The genus *Macrobrachium* of the family Palaemonidae is represented by five species, namely, *M. lamarrei lamarrei* (H. Milne Edwards, 1837), *M. malcolmsonii* (H. Milne Edwards, 1844), *M. peguense* (Tiwari, 1952), *M. scabriculum* (Heller, 1952) and *M. unikarnatakae* Jalihal *et al.*, 1988, of which *M. peguense* and *M. unikarnatakae* are new records to Tamilnadu. The genus *Caridina* of the family Atyidae is also represented by five species, namely, *C. gracilipes* De Man, 1892, *C. gurneyi* Jalihal *et al.*, 1984, *C. kunnathurensis* Richard & Chandran, 1994, *C. williamsoni* Jalihal *et al.*, 1984 and *C. typus* H. Milne Edwards, 1837.

INTRODUCTION

The paddy field at Singaperumalkoil is situated about 50 km south of Chennai. On either side of the main road from Chennai to Chingelput up to the bifurcation leading to Sriperumpudur, there are very fertile rice fields. Here cultivation of rice is carried out throughout the year (Three cycles) especially because of the abundant water availability. Unique limnological conditions prevail in the rice fields dissimilar to other natural aquatic habitats although they share some features of marshes, shallow lakes and ponds. Although biological cycles are interrupted by cultivation, colonization in the aquatic phase can be rapid by zooplankton, benthos and nektonic animals along with phytoplankton and macrophytes. There is a rapid buildup of diversity of aquatic organisms after the planting of rice. Although this profusion of species may be short-lived their production biologically can be very high. But no detailed account is available on the faunal composition of paddy fields during aquatic and semi aquatic phases. Hence studies pertaining to aquatic and semi

aquatic phases of rice fields were undertaken with special reference to prawn and shrimp diversity. Though the studies were carried out in an area of 4.5 ha of paddy field behind Singaperumalkoil railway station, yet they were confined mostly to an easily accessible plot of 100 sq. m.

MATERIAL AND METHODS

From April 1998 to March 2000 regular monthly collections of prawns along with other aquatic organisms like fish, crab and molluscs were made in the paddy field located at Singaperumalkoil. Prawns were collected by using a net cloth of 2 m length and 1 m width. For each sample the net was operated for four times. Collected prawns were fixed in 4% formalin and preserved in 70% alcohol. Later the specimens were identified to species (Jalihal *et al.*, 1984 and 1988, Richard & Chandran, 1994 and Jayachandran, 2001) and details of population studies will be published elsewhere.

TAXONOMIC NOTE OF PRAWNS COLLECTED

Phylum	ARTHROPODA
Subphylum	CRUSTACEA
Class	MALACOSTRACA
Order	DECAPODA
Superfamily	ATYOIDEA De Hann, 1849
Family	ATYIDAE De Hann, 1849
Genus	***Caridina*** H. Milne Edwards, 1837

Key to the Identification of species under *Caridina*

1. Rostrum as long as or slightly longer than the antennal scale 2
– Rostrum distinctly shorter than the antennal scale 3

2. Rostrum with spines arranged throughout the length of the dorsal margin without distal gap ..... *C. williamsoni*
– Rostrum with spines compactly arranged on the proximal part of the dorsal margin but leaving a wide gap distally 4

3. Dorsal margin of the reostrum smooth without spine ..... *C. typus*
– Dorsal margin of the rostrum with 17–25 spines ..... *C. gurneyi*

4. The distal wide gap of the dorsal margin of the rostrum always interrupted by 0–5 small teeth and without any sub terminal teeth ..... *C. kunnathurensis*
– The distal wide gap of the dorsal margin of the rostrum mostly without intermediate spines, rarely it may be interrupted by 1 or 2 small spines and always posses a sub terminal tooth ..... *C. gracilipes*

Caridina gracilipes De Man, 1892

1892. *Caridina nilotica* var. *gracilipes*, De Man, *Max. Weber Zool. Ergeb.*, **2** : 387.

1994. *Caridina gracilipes* Richard & Chandran, *J. Bombay nat. Hist. Soc.*, **91**(2) : 242-259.

1997. *Caridina gracilipes* Mariappan, *Ph.D. Thesis*, Unpublished, Madras University.

Material examined : 12GG, 12EE and 2 juveniles.

Diagnostic characters : Rostrum straight, equal to or slightly longer than the antennal scale. Rostral formula 17–24/14–17. Dorsal margin of the rostrum with a distal gap which is occasionally interrupted by one or two teeth. The tip of the rostrum is provided with one or two sub apical teeth rarely this is absent in some animal. Carpus of the first cheliped with slight anterior excavation and is 2.25 times as long as its breadth. Carpus of the second cheliped without any excavation and 5.3 times as long as its breadth. Propodus of the third pereiopod 4.4 times as long as dactylus. Dactylus is 3.33 times as long as its breadth. Fifth pereiopod with propodus 3.37 times as long as dactylus and dactylus 4 times as long as its breadth. First pleopod of male with a well developed appendix interna. A dorsal hump is observed on the 3rd abdominal segment. Exopod of the uropod with 10 to 12 spines.

Distribution : Pondichery, Tamilnadu.

Caridina gurneyi Jalihal *et al.*, 1984

1984. *Caridina gurneyi* Jalihal *et al.*, *Rec. zool. Surv. India*, *Occ. Paper*, **69** : 1-40.

1994. *Caridina gurneyi* Richard & Chandran, *J. Bombay nat. Hist. Soc.*, **91**(2) : 242-259.

1997. *Caridina gurneyi* Mariappan, *Ph.D. Thesis*, Unpublished, Madras University.

Material examined : 11EE (3 berried).

Diagnostic characters : Rostrum straight, reaches ½ to ¾th of the antennular peduncle. Rostral formula 17–25/5–9 (3–6). The spines are arranged compactly both in the dorsal and ventral surface throughout the length of the rostrum except its tip. Carpus of the first cheliped with deep anterior excavation and is 2 times as long as its breadth. Carpus of the second cheliped without any excavation and 3.29 times as long as its breadth. Propodus of the third pereiopod 4.6 times as long as dactylus. Dactylus is 2.67 times as long as its breadth, merus possess 5 spines and ischium has 1 spine. Propodus of the fifth pereiopod 4.13 times as long as dactylus. Dactylus is 3.75 times as long as its breadth, merus possess 4 spines and ischium is without any spine. First pleopod of male with a well developed appendix interna. No dorsal hump is observed on the 3rd abdominal segment. Exopod of the uropod with 15 to 18 spines.

Distribution : Karnataka, Tamilnadu.

Caridina kunnathurensis Richard & Chandran, 1994

1994. *Caridina kunnathurensis* Richard & Chandran, *J. Bombay nat. Hist. Soc.*, **91**(2) : 242-259.

1997. *Caridina kunnathurensis* Mariappan, *Ph.D. Thesis*, Unpublished, Madras University.

Material examined : 138GG, 288EE and 40 juveniles.

Diagnostic characters : Rostrum slightly upturned distally, equal to or slightly longer than the antennal scale. Rostral formula 15–30/6–16 with 3–5 spines on the carapace. Dorsal margin of the rostrum with a distal gap which is often interrupted by 1–6 teeth. Carpus of the first cheliped with sligt excavation and is 2.1 times as long as its breadth. Carpus of the second cheliped without any excavation and 5.3 times as long as its breadth. Propodus of the third pereiopod 4.67 times as long as dactylus. Dactylus is 2.67 times as long as its breadth. Propodus of the fifth pereiopod 3.7 times as long as dactylus. Dactylus is 3.89 times as long as its breadth. First pleopod of male with well developed appendix interna over reaching the enodpod. Posterior margin of the telson with 4 to 5 pairs of plumose process. The exopod of the uropod with 10–12 movable spines.

Distribution : Tamilnadu.

Caridina williamsoni Jalihal *et al.*, 1984

1947. *Caridina nilotica* var. *chouhani* Chopra and Tiwari, *Rec. Ind. Mus.*, **45** : 213-224.

1984. *Caridina williamsoni* Jalihal *et al.*, *Rec. zool. Surv. India, Occ. Paper*, **69** : 1-40.

1997. *Caridina williamsoni* Mariappan, *Ph.D. Thesis*, Unpublished, Madras University.

Material examined : 11GG, 26EE (18 berried) and 10 juveniles.

Diagnostic characters : Rostrum straight, equal to or slightly longer or shorter than the antennal scale. Rostral formula 30–45/7–12. In the dorsal margin of the rostrum spines are arranged throughout the length of the rostrum without any gap. In the ventral margin spines are arranged leaving ¼ of the distal end. Carpus of the first cheliped with slight anterior excavation and is 2 times as long as its breadth. Carpus of the second cheliped without any excavation and 4.67 times as long as its breadth. Propodus of the third pereiopod 4.13 times as long as dactylus and the dactylus is 3.3 times as long as breadth. Fifth pereiopod with propodus 3.5 times as long as dactylus and dactylus 3 times as long as its breadth. First pleopod of male with a well developed appendix interna. A dorsal hump is observed on the 3rd abdominal segment. Exopod of the uropod with 9 to 15 spines.

Distribution : Karnataka, Orissa, Tamilnadu.

Caridina typus H. Milne Edwards, 1837

1837. *Caridina typus* H. Milne Edwards, *His. Nat. Crust.*, **2** : 1-532.

1999. *Caridina typus* Delphin & Richard, *J. Bom. nat. Hist. Soc.*, **96**(3) : 427-432.

Material examined : 1G.

Diagnostic characters : Rostrum smooth sloping down and reaches ¾th of the second antennular segment. The dorsal surface of the rostrum is characterized by the absence of spines, and the ventral edge of the rostrum carries 5 spines. Carpace is much longer than the rostrum (nearly 2.7 times).

Apendix masculina stronger and reaches more than ¾th of the endopod of second pleopod. The exopod of the uropod bears 17 movable spines.

Distribution : Andaman Islands, Tamilnadu.

Remarks : This species was reported for the first time to the Indian main land by Delphin and Richard (1999) from Kanyakumari district. For the second time its presence in Indian mainland is confirmed during the present study.

Superfamily PALAEMONOIDEA Refinesque, 1815
Family PALAEMONIDAE Refinesque, 1815
Subfamily PALAEMONINAE Refinesque, 1815
Genus ***Macrobrachium*** Bate, 1868

Key to the Identification of Paddy Field *Macrobrachium*

1. Second cheliped is simple and not sexually dimorphic 2
– Second cheliped strong, well developed and sexually dimorphic 3
2. Rostrum shorter than or sub equal ot the antennal scale 4
– Rostral length varies considerably, generally longer than antennal scale. In adult male apendix masculina of second pleopod slender and equal to or slightly longer than the endopod ..... *M. lamarrei lamarrei*
3. The second chelipeds of the same animal (male) itself is unequal, either left or right leg well developed ..... *M. scabriculum*
– The second chelipeds of the same animal (male) is similar and both the chelipeds are well developed ..... *M. malcolmsonii*
4. Exopod of the uropod with a accessory sub apical spine ..... *M. unikarnatakae*
– Exopod of the uropod without accessory sub apical spine ..... *M. peguense*

Macrobrachium lamarrei lamarrei (H. Milne Edwards, 1837)

1837. *Palaemon lamarrei* H. Milne Edwards, *Hist. Nat. Crustaces*, **II** : 397.
2001. *Macrobrachium lamarre lamarrei* Jayachandran, Palaemonid Prawns Biodiversity, Taxonomy, Biology and Management. *Oxford & IBH Publishing Co. Pvt. Ltd. Calcutta*, 1-624.
2004. *Macrobrachium lamarrei lamarrei* Roy *et al., Zool. Surv. India, State Fauna Series, Fauna of Manipur*, **10** : 119-123.

Material examined : 338GG, 700EE.

Diagnostic characters : Rostrum with small crest over the orbital region. Rostral formula 4–13/4–8 (1–2). In the dorsal margin of the rostrum the proximal group of 5 to 10 teeth is seperated

from the 1 or 2 sub apical teeth by a wide gap. Carapace mostly shorter than the rostrum rarely it is equal to the rostrum. The second cheliped are simple and similar in both the sex. In this the fingers are more or less equal the palm, carpus is longer than the chela (1.55 to 2.07 times). The important character which differentiate the present species from other closely related species is its longer slender appendix masculina which overreaches the endopod or at least equal to or very slightly shorter (in young males) than the endopod of the second pleopod. The exopod of the uropod is without accessory spine. Number of eggs ranges from 31–64 and the size of the egg ranges 1.4–1.6 × 1.0–1.2.

Distribution : Common in India.

Remarks : This is a very common species in Tamilnadu. In the paddy field this species dominates all the other species in number as well as its availability in all the seasons.

Macrobrachium malcolmsonii (H. Milne Edwards, 1844)

1844. *Palaemon malcolmsonii* H. Milne Edwards, *In* : *Jacquemont Voyage, Inde*, **4**(2) : 8.

2001. *Macrobrachium malcolmsoni* Jayachandran, Palaemonid Prawns Biodiversity, Taxonomy, Biology and Management. *Oxford & IBH Publishing Co. Pvt. Ltd. Calcutta*, 1-624.

Material examined : 1G (144 mm) and 1E (berried, 95 mm).

Diagnostic characters : Upper margin of the rostrum with 11 to 12 teeth of which 3 teeth present on the carapace. Ventral margin of the rostrum with 6 teeth. Carapace smooth. The second cheliped is strong and well developed in the males and over reaches the antennalscale by its entire chela and 4/5th of the carpus. In the second cheliped fingers are shorter than palm, carpus shorter than the chela but longer palm. Merus shorter than carpus and palm but longer than fingers. The movable finger is covered with pubescent hairs except its tip, and is provided with two prominent denticles. The immovable finger has one strong and two weak denticles. The entire cheliped is tuberculate and is shorter than its total body length (0.64 times of its total body length).

Distribution : All over India.

Macrobrachium peguense (Tiwari, 1952)

1952. *Palaemon peguense* Tiwari, *Ann. Mag. Nat. Hist.*, **V** (ser. 12) : 27.

2001. *Macrobrachium peguense* Jayachandran, Palaemonid Prawns Biodiversity, Taxonomy, Biology and Management. *Oxford & IBH Publishing Co. Pvt. Ltd. Calcutta*, 1-624.

2005. *Macrobrachium peguense* Raghunathan & Valarmathi, *Rec. zool. Surv. India*, **105** (part 3-4) : 51-56.

Material examined : 10GG and 8EE.

Diagnostic characters : Rostrum always longer than the antennular peduncle and slightly shorter than or rarely equal to the antennal scale. Rostral formula 6–10/3–5 usually with 7–9/3–4, with one or two post orbital teeth. In the lower margin of the rostrum, teeth are equidistant but in the

upper margin though the teeth are equidistant slight variations in distance are also observed. The upper margin is with or without sub apical teeth if present also it is not widely separated from the remaining teeth.

The second cheliped is equal on both the sides and similar in both the sexes. It is sub equal to the half of the total body length. It over reaches the antennal scale by the entire chela and 1/5th of the carpus. In males the length of the cheliped is 1 or 2 mm shorter than the half of the total body length, but in females it is 0.3 to 3.6 mm longer than the half of the total body length. Carpus is distinctly longer than the merus. Chela is sub equal to the carpus. Mostly carpus is slightly longer (0.1–1.1 mm) than the chela, occasionally it is equal to or slightly (0.1–1.1 mm) shorter than the chela. Finger is always shorter than the palm (0.6–0.8 mm) with delicate hairs at the tip. Cutting edges of both movable and immovable fingers of males are smooth without any tubercles. But in the case of females cutting edge of the movable finger usually armed with 2 minute tubercle like teeth, while that of the fixed finger with a smaller tooth fitting in the gap between those of the movable finger when closed, rest of the cutting edge smooth. Palm is mostly longer than the half of the carpus but in rare cases it is slightly (0.05–0.2 mm) shorter than the half of the carpus, irrespective of size and gender. Carpus is always longer than the merus, cylindrical and is 6.8 to 11.6 (average = 9.35) times as long as its distal diameter. The number of eggs varies from 67–122 and size of the eggs ranges fro 1.2–1.8 × 0.9–1.5 mm. The length of the berried female lies between 37–44 mm.

Distribution : Myanmar, Karnataka.

Remarks : This species is a new report to Tamilnadu. Earlier this species was described from Myanmar by Tiwari (1952), later it was recorded from Bilgiri Rangasamy temple Wild Life Sanctuary (Raghunathan and Valarmathi, 2005).

Macrobrachium scabriculum (Heller, 1952)

1852. *Palaemon scabriculus* Heller, *Verh. Zool.-bot, Ges. Wien.*, **12** : 527.

2001. *Macrobrachium scabriculum* Jayachandran, Palaemonid Prawns Biodiversity, Taxonomy, Biology and Management. *Oxford & IBH Publishing Co. Pvt. Ltd. Calcutta*, 1-624.

Material examined : 1E.

Diagnostic characters : Rostrum, short sloping down and nearly reaches the antennular peduncle. The rostral formula is 13–14/3(4). The second pereiopod is strongly unequal, the right one is larger than the left. The carapace is scabrous with minute prickles and its length is 2 times of the length of the rostrum. The largest second pereiopod is longer than the total body length. The palm and the proximal part of the finger are covered with wooly hairs. The movable finger is provided with 17 tubercles. In the larger second pereiopod the finger is shorter the palm but longer than the remaining segments, carpus is longer than the ischium but shorter than the merus, palm and the finger.

The immovable finger is provided with 18 tubercles of which the proximal first one is largest. The size of the tubercles decreases towards the distal end. The fingers are compressed and slightly curved at the tip. The smaller second pereiopod is provided with long velvety hairs throughout its entire length even in the cutting edges of the finger. In this finger is sub equal to the palm the remaining proportions are like the larger second pereiopod. The exopod of the uropod is provided with a accessory sub apical spine.

Distribution : Karnataka, Kerala, Pondichery, Orissa, Tamilnadu.

Macrobrachium unikarnatakae Jalihal *et al.*, 1988

1988. *Macrobrachium unikarnatakae* Jalihal *et al.*, *Rec. zool. Surv. India, Occ. Paper*, **112** : 21.

2001. *Macrobrachium unikarnatakae* Jayachandran, Palaemonid Prawns Biodiversity, Taxonomy, Biology and Management. *Oxford & IBH Publishing Co. Pvt. Ltd. Calcutta*, 1-624.

Material examined : 1E (berried, 52.9 mm).

Diagnostic characters : Rostrum longer than the antennular peduncle but falls short of the antennalscale. The rostral formula is 7/3(2). Carapace is distinctly longer than the rostrum. The second cheliped is simple, in that finger is shorter than palm, the chela is shorter that the total length of the carpus but slightly longer than 3/4th of the carpus. Merus is shorter than carpus but longer than palm. Exopod of the uropod with accessory sub apical spine. The female carries 185 eggs the size of which ranges from 1.2–1.4 × 1.15–1.25.

Distribution : Karnataka.

Remarks : *Macrobrachium unikarnatakae* is considered as an endemic species to Karnataka. For the first time this species is reported outside Karnataka from Tamilnadu.

DISCUSSION

So far prawns of the genus *Caridina* (Family : Atyidae) and *Macrobrachium* (Family : Palaemonidae) have been reported from freshwater bodies like river, pond, lake, stream *etc.*, (Jalihal *et al.*, 1988; Miriappan, 1997) and for the first time their occurrence and diversity is revealed in a paddy field. Among the *Macrobrachium* species collected, the following namely *M. lamarrei lamarrei*, *M. malcolmsonii* and *M. scabriculum* are culturable species. From Tamilnadu, *Macrobrachium peguense* (Tiwari) and *Macrobrachium unikarnatakae* Jalihal *et al.*, are new records. The latter species is recorded out of Karnataka for the first time.

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Rec. zool. Surv. India : **107**(Part–2) : 103-112, 2007

BUTTERFLIES OF SUR SAROVAR BIRD SANCTUARY, KEETHAM, AGRA (UTTAR PRADESH, INDIA)

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INTRODUCTION

Sur Sarovar Bird Sanctuary is named after the famous poet Surdas. Declared as Bird Sanctuary by the Uttar Pradesh government in 1991, the sanctuary is spread over 713 hectares. A lake having an area of 300 hectares is present in the middle of the sanctuary. The depth of the lake ranges between 5–8 metres. Sur Sarovar Bird Sanctuary is situated on the Agra-Mathura-Delhi National Highway (No. 2), at a distance of 20 kms. from the famous historical city, Agra. This bird sanctuary is situated on the bank of river Yamuna. The sanctuary is located between 77°–26' E to 78°–51' E longitudes and 26°–43' N to 27°–26' N latitudes. The temperature varies from 5°–48°C and the rainfall varies from 517 mm to 750 mm. The sanctuary supports 105 species of birds. The vegetation of this zone comprises of grasses, *Eucalyptus*, *Zizypus*, *Delbergia*, *Lantana* etc.

The butterfly fauna of Uttar Pradesh has been previously studied by Marshall and de Niceville (1882), de Niceville (1886, 1890), Evans (1932), Talbot (1939, 1947) and Wynter-Blyth (1957). A perusal of literature reveals that nothing is known about the insect fauna of the Sur Sarovar Bird Sanctuary, Agra. The present work is an attempt to provide a comprehensive account of Rhopalocera found in the Sanctuary. The article deals with an account of twenty species, thirteen genera and six families *i.e.*, Pieridae, Danaidae, Satyridae, Nymphalidae, Lycaenidae and Hesperiidae, of which first five belong to superfamily Papilionoidea and last to the superfamily Hesperiodea. All the species dealt with this account are reported for the first time from this Sanctuary.

SYSTEMATIC ACCOUNT

Phylum ARTHROPODA
Class INSECTA
Order LEPIDOPTERA
Suborder RHOPALOCERA

Family 1. PIERIDAE

Genus 1. ***Cepora*** Billberg, 1820

1. ***Cepora nerissa phryne*** (Fabricius)

1775. *Papilio phryne* Fabricius, *Syst. Ent.*, : 473.

1939. *Cepora nerissa phryne* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 362.

Common name : The Common Gull.

Material examined : 3 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 2 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Assam; Bihar; Sikkim; Madhya Pradesh; Maharashtra; Tamil Nadu; North-West Himalayas.

Elsewhere : Nepal.

Genus 2. ***Catopsilia*** Huebner, 1819

2. ***Catopsilia pomona*** (Fabricius)

1775. *Papilio pomona*, Fabricius, *Syst. Ent.*, : 479.

1939. *Catopsilia pomona* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 493.

1993. *Catopsilia crocale* : Varshney, Oriental Ins., **27** : 362.

Common name : The Lemon Emigrant.

Material examined : 2 exs., Near Entry Gate, 3 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Andaman and Nicobar; Delhi; Bihar; Maharashtra; Tamil Nadu; West Bengal; North-West Himalayas.

Elsewhere : Sri Lanka; Pakistan; Myanmar; South China; Australia

3. ***Catopsilia pyranthe pyranthe*** (Linnaeus)

1775. *Papilio pyranthe*, Linnaeus, *Syst. Nat.* (ed. 10), : 469.

1939. *Catopsilia pyranthe pyranthe* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 497.

Common name : The Mottled Emigrant.

Material examined : 3 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 1 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Andamans; Assam; Gujarat; Tamil Nadu; West Bengal; North-West Himalayas.

Elsewhere : South China; Burma; Java; Sulawesi; Philippines; Sri Lanka; Pakistan.

Genus 3. ***Eurema*** Huebner, 1819

4. ***Eurema hecabe fimbriata*** (Wallace)

1867. *Terias fimbriata* Wallace, *Trans. Ent. Soc. Lond.*, **4** : 323.

1939. *Eurema hecabe fimbraita* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 531-532.

1993. *Terias hecabe* : Varshney, *Oriental Ins.*, **27** : 363.

Common name : The Common Grass Yellow.

Material examined : 5 exs., Near Entry Gate, 4 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 5 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Bihar; Assam; Delhi; Himachal Pradesh; Maharashtra; Karnataka; Tamil Nadu; West Bengal; Lakshadweep.

Elsewhere : Sri Lanka.

Genus 4. ***Ixias*** Huebner, 1819

5. ***Ixias pyrene kausala*** Moore

1877. *Ixias kausala* Moore, *Ann. Mag. Nat. Hist.*, (4)**20** : 49.

1939. *Ixias pyrene kausala* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 446.

Common name : The Yellow Orangetip.

Material examined : 4 exs., Near Entry Gate, 3 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 6 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Punjab; Kumaon; Uttar Pradesh; Sikkim; Assam; Peninsular India to Bengal; Andaman Islands.

Elsewhere : Japan; Formosa to China; Malaya peninsula; Sri Lanka; Myanmar; Pakistan.

Genus 5. ***Colotis*** Huebner,1819

6. ***Colotis fausta faustina*** (C. & R. Felder)

1865. *Idmais faustina*, C. & R. Felder, *Reise Novara, Lep.*, **2** : 190.

1939. *Colotis fausta faustina* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 462.

Common name : The Large Salmon Arab.

Material examined : 3 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 4 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Delhi; Uttar Pradesh; throughout the Peninsula.

Elsewhere : Afghanistan; Pakistan; Sri Lanka; Turkry; Egypt; Iran; Palestine to Arabia; Egypt.

7. ***Colotis etrida etrida*** (Boisduval)

1836. *Anthocharis etrida* Boisduval, *Spec. Gen. Lep*., **1** : 576.

1939. *Colotis etrida etrida* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 465.

Common name : The Little Orange Tip.

Material examined : 5 exs., Near Entry Gate, 3 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 5 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Delhi; Uttar Pradesh; Peninsular India to Himalayas.

Elsewhere : Pakistan; Sri Lanka.

8. ***Colotis calais amata*** (Fabricius)

1775. *Papilio amata* Fabricius, *Syst. Ent*., : 476.

1939. *Colotis calais amata* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 454-455.

Common name : The Small Salmon Arab.

Material examined : 2 exs., Near Entry Gate, 1 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 1 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Delhi; Uttar Pradesh; North-West to Peninsula.

Elsewhere : Ethiopia; Syria to Iran; Arabia; Pakistan; Sri Lanka.

9. ***Colotis vestalis vestalis*** (Butler)

1876. *Teracolus vestalis* Butler, *Ent. Mo. Mag.*, **23** : 135.

1939. *Colotis vestalis vestalis* : Talbot, *The Fauna of Brit. India*, Butterflies, **1** : 457-459.

Common name : The White Arab.

Material examined : 1 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 1 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Punjab; Uttar Pradesh; North-West India.

Elsewhere : Kenya to Abyssinia; Pakistan.

Family 2. SATYRIDAE

Genus 6. ***Ypthima*** Huebner, 1818,

10. ***Ypthima inica*** Hewitson

1865. *Ypthima inica* Hewitson, *Trans. Ent. Soc. Lond*., (3)**2** : 284.

1994. *Ypthima inica* : Varshney, *Oriental Ins*., **28** : 159.

Common name : The Lesser Three Ring.

Material examined : 6 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Central India; Punjab; West Bengal.

Family 3. NYMPHALIDAE

Genus 7. ***Junonia*** Huebner, 1819

11. ***Junonia almana almana*** (Linnaeus)

1758. *Papilio almana* Linnaeus, *Syst. Nat.* (ed. 10) : 472.

1987. *Precis almana almana* : Gupta & Shukla, *Rec. zool. Surv. India, Occ. Pap. No.* **106** : 35.

1994. *Junonia almana* : Varshney, *Oriental Ins.*, **28** : 176.

Common name : The Peacock Pansy.

Material examined : 2 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Bihar; Delhi; West Bengal; Orissa; Punjab; Andamans (Widely distributed throughout India excluding Car Nicobar).

Elsewhere : Sri Lanka; Myanmar

12. ***Junonia orithya swinhoe*** Butler

1885. *Junonia swinhoe*, Butler, *Ann. Mag. nat. Hist.*, **5**(16) : 316.

1987. *Junonia orithya swinhoe* : Gupta & Shukla, *Rec. zool. Surv. India, Occ. Pap. No.* **106** : 33.

1994. *Junonia orithya* : Varshney, *Oriental Ins.*, **28** : 176.

Common name : The Blue Pansy.

Material examined : 3 exs., Near Entry Gate, 1 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Punjab; Bihar; Delhi; Himachal Pradesh; Orissa; South India.

Elsewhere : Sri Lanka; Baluchistan; Pakistan; Myanmar.

13. ***Junonia lemonias persicaria*** (Fruhstorfer)

1912. *Precis persicaria* Fruhstorfer, In Seitz; *The Macrolepidoptera of the World*, **9** : 520.

1932. *Precis lemonias persicaria :* Evans, *The identification of Indian Butterflies* : 176.

1994. *Junonia lemonias* : Varshney, *Oriental Ins.*, **28** : 176.

Common name : The Lemon Pansy.

Material examined : 3 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 2 exs., 5.ix.2005, Surdas House, Coll. N Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Bihar; Himachal Pradesh; Orissa; South India.

Elsewhere : Sri Lanka.

Genus 8. ***Hypolimnas*** Huebner, 1819

14. ***Hypolimnas missipus*** (Linnaeus)

1764. *Papilio misippus* Linnaeus, *Mus. Ulr.*, : 264.

1932. *Hypolimnas misippus* : Evans, *The Identification of Indian Butterflies* : 173.

1994. *Hypolimnas misippus* : Varshney, *Oriental Ins.*, **28** : 177.

Common name : The Danaid Eggfly.

Material examined : 4 exs., Near Entry Gate, 1 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 2 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Punjab; Bihar; Delhi; Orissa; Arunachal Pradesh; Sikkim : Tamil Nadu; Andaman and Nicobar; West Bengal.

Elsewhere : Pakistan; Myanmar; Sri Lanka

Family DANAIDAE

Genus 9. ***Danaus*** Kluk, 1780

15. ***Danaus chrysippus chrysippus*** (Linnaeus)

1758. *Papilio chrysippus* Linnaeus, *Syst. Nat*. (ed. 10) **1** : 471.

1947. *Danaus chrysippus chrysippus* : Talbot, *The Fauna of Brit. India, Butterflies*, **2** : 20

Common name : The Plain Tiger.

Material examined : 10 exs., Near Entry Gate, 4 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 5 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Punjab; Bihar; Delhi; Orissa; Manipur; Sikkim; Gujrat; Maharashtra; Tamil Nadu; Himachal Pradesh; Andaman and Nicobar; West Bengal.

Elsewhere : Nepal; Pakistan; Bhutan; Sri Lanka; Myanmar; Indonesia; China.

16. ***Danaus genutia*** (Cramer)

1779. *Papilio genutia* Cramer, *Pap. Exot.*, **3** : 23.

1947. *Danaus plexippus plexippus* : Talbot, *The Fauna of Brit. India*, Butterflies, **2** : 25.

1987. *Danaus genutia* : Gupta & Shukla, *Rec. zool. Surv. India*, Occ. Pap. No. **106** : 17.

Common name : The Common Tiger.

Material examined : 2 exs., Near Entry Gate, 1 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 1 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Assam; Bihar; Delhi; Orissa; Punjab; Manipur; Mizoram; Sikkim; Nagaland; Rajasthan; Tamil Nadu; Arunachal Pradesh; Karnataka; Himachal Pradesh; Andaman and Nicobar; West Bengal.

Elsewhere : Thailand; Nepal; Pakistan; Afghanistan; Bhutan; Sri Lanka; Myanmar; South China.

Genus 10. ***Tirumala*** Moore, 1880

17. ***Tirumala limniace leopardus*** (Butler)

1866. *Danaus limniace* var. *leopardus* Butler, *Proc. zool. Soc. Lond.*, : 52.

1947. *Danaus limniace leopardus* : Talbot, *The Fauna of Brit. India, Butterflies*, **2** : 31.

1991. *Tirumala limniace leopardus :* Mandal & Maulik, *State Fauna Series* 3 : *Fauna of Orissa*, Part-3, *Zool. Surv. India* : 235.

Common name : The Blue Tiger.

Material examined : 2 exs., Near Entry Gate, 4.ix.2005, Coll. N. Sharma; 1 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Assam; Bihar; Delhi; Orissa; Punjab; Uttaranchal; Manipur; Sikkim; Nagaland; Tamil Nadu; Karnataka; Himachal Pradesh; Andaman and Nicobar; West Bengal.

Elsewhere : Thailand; Nepal; Pakistan; Afghanistan; Sri Lanka; Myanmar; South China

Genus 11. ***Euploea*** Fabricius 1807

18. ***Euploea core core*** (Cramer)

1780. *Papilio core* Cramer. *Pap. Exot.*, **3** : 133.

1947. *Euploea core core* : Talbot, *The Fauna of Brit. India*, Butterflies, **2** : 67.

Common name : The Common Crow.

Material examined : 2 exs., Near Entry Gate, 1 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 2 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Uttar Pradesh; Madhya Pradesh; Bihar; Delhi; Orissa; Sikkim; Uttaranchal; Tamil Nadu; Karnataka; Himachal Pradesh; Andaman and Nicobar; West Bengal.

Elsewhere : Northern Myanmar; Sri Lanka; Nepal; Pakistan.

Family LYCAENIDAE

Genus 12. ***Tarucus*** Moore, 1881

19. ***Tarucus callinara*** Butler

1886. *Tarucus callinara* Butler, *Ann. Mag. Nat. Hist. Lond.*, (5)**18** : 185.

1907. *Tarucus theophrastus* : Bingham, *The Fauna of British India (Butterflies)*, **2** : 417.

1962. *Tarucus callinara* : Cantile, the Lycaenidae portion (except the Arhopala Group) of Brigadier Evans' *The Identification of Indian Butterflies*, 1932 : 33.

Common name : The Spotted Pierrot.

Material examined : 4 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Punjab to Bengal; Uttar Pradesh.

Elsewhere : Pakistan; Myanmar.

Family HESPERIIDAE

Genus 13. ***Caltoris*** Swinhoe, 1893

20. ***Caltoris cahira*** (Moore)

1877. *Parnara cahira* Moore, *Proc. zool. Soc. Lond.*, : 593.

1949. *Caltoris cahira* : Evans, *A Catalogue of the Hesperiidae from Europe, Asia and Australia in Brit. Mus. (nat. Hist)* : 452.

Common name : The Colon Swift.

Material examined : 4 exs., Near Entry Gate, 2 exs., Near Keetham Lake, 4.ix.2005, Coll. N. Sharma; 3 exs., 5.ix.2005, Surdas House, Coll. N. Sharma.

Distribution : India : Sikkim; Assam; West Bengal; Meghalaya; Manipur; Andaman and Nicobar.

Elsewhere : Pakistan; Myanmar.

SUMMARY

Twenty species and subspecies of butterflies representing thirteen genera and six families are reported for the first time from Sur Sarovar Bird Sanctuary, Agra, Uttar Pradesh.

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COMMENTARY

'INDFAUNA' CATALOGUING : AN EMPIRICAL ASSESSMENT

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INTRODUCTION

Chavan, *et al.* (2004) in their General Article have made a point very categorically that the developing nations, such as India, having richer stock of biodiversity, have not paid a deserving attention to the concept of the electronic cataloguing of their known asset of biodiversity in the well-reasonably advanced era of bioinformatics. They have remarked on the imperatives for the developing nations to keep pace with the developed nations, joining with them, to become an integral part of the web portal system aimed at creating a validated unitary index system cataloguing the world's known organisms. In this context they have made a vibrant appeal calling for encouraging the country to undertake the electronic cataloguing (ECAT) of hitherto known biodiversity resources of India, and as well moved a step ahead initiating a web portal system, under the name 'IndFauna' (*http://www.ncbi.org.in/biota/fauna*), for cataloguing the complete identified and known fauna of the country.

The web portal system cataloguing the Indian Fauna created by them reveals that they have joined the league of biodiversity experts, a select band of leading biodiversity researchers and proponents arguing for developing the Catalogue of Life through an international consortium—a collaboration forged under alliance between Species 2000 (www.sp.2000.org) based in UK and Japan, and the Integrated Taxonomic Information System (ITIS) (www.itis.usda.gov) based in USA, and also with other major bodies like All Species Foundation (www.all-species.org) and the Global Biodiversity Information Facility (GBIF) (www.gbif.gbif.org). The consortium aims to make a concerted effort to 'reinvent' taxonomy for the online generation, with the ambitious goal of creating a federation of databases that would collectively catalogue the world's biota (Gewin, 2002; Godfray, 2002).

ECAT IndFauna programme takes in its fold, arguably, all the available fauna described from the country so far, making it quite distinct from other efforts of electronic documentation of known Indian fauna, of certain groups or categories, many of the institutions in the country have been undertaking. It is claimed that the database processes initiated by Chavan, *et al.* (2004) have achieved the compilation of "more than 93% of the 90,000 known faunal species in India" assumingly rendered with a notion that the ECAT programme is progressing fast, very much in tune with the concept and content of the Global Biodiversity Information Facility (GBIF).

However, in the absence of a categorical expression about the scientific authenticity of the database entries, the claimed output of more than 93% of the catalogued Indian fauna does not imply that the indexed data comprise exclusively of the scientific names of the valid taxa alone. It appears that the ECAT has obviously or inevitably incorporated the pertinent synonyms of taxa also under valid scientific names. Once synonyms of taxa come in the picture, the indexed/compiled data-output is likely to be a bloated one with profusion of nomenclature, which may render confusion to a needy end user—not necessarily to a taxonomist—on the validity/status of the nomenclature. While making catalogue of species based on the updated review and revisionary taxonomic works over a period of time, there is little scope for synonyms standing for the sake of valid species, or minimal if imperative. In the case of ECAT of IndFauna, it is believed to have overshot to more than 80% in certain taxonomic groups (Chandra, 2005). Thus, the claim of more than 93% of the known fauna of the country having been already incorporated in the ECAT Ind-Fauna programme does not bear the onus of proof that it contains only the valid names of the hitherto known taxa.

While Chavan and party's endeavor needs to be appreciated, it as well seems to have the potential to generate certain genuine concern about the programme. A miscellany of ambiguities, some of them serious ones, noticed in the ECAT of IndFauna is illustrated here. In many valid scientific names of species recorded in the ECAT version, the binomial system of nomenclature depicting the species—the system that locks up a genus name to a specific name to represent the scientific name of a particular species under its authentic family/order, as per the principles of classification—has gone haywire, thus the actually indented species being depicted as mere abstract names, not valid to science.

Among the indexed species include the scientific names representing the genus/genera of a family/order binomially linked with the specific names unrelated to them, or found associated with some other genus/genera of a different family/order, absolutely unrelated to it. The web-page of the site [*http://www.ncbi.org.in/biota/fauna*—developed by the National Chemical Laboratory (NCL), Pune] listing the recorded species, claimed to be the scientific names, opened and examined as on 27-7-2005, enumerates the insect species belonging to the genus *Curculio* under the family Curculionidae (Coleoptera : Insecta), wrongly categorized as species under the

family Tephritidae (fruit flies) of the order Diptera (Insecta). *Curculio coimbatorensis*, for example, is placed under the family Tephritidae of the order Diptera, thus rendering it an absurd, abstract identity, differentiating itself neither as an insect species of the family either Curculionidae (Coleoptera) or Tephritidae (Diptera). An additional 9 more such 'species' of *Curculio* reflects under the family Tephritidae. Many such fanciful names, unknown to science, have crept into the electronically indexed system. In each case of such an anomalous depiction of a scientific name, there arises the possibility of emerging out a minimum count of two ambiguous species with transposed names of the genus/species.

We all know the common name *Jamun* means a plant, rather a tree, not an animal, in any way. A botanist identifies it with its scientific name *Syzygium cumini* (L.) Skeels (with the synonym *Eugenia jambolana* Lank). In any sensible taxonomic cataloguing system—whether textual or electronic version—one would expect the scientific name *Eugenia jambolana* in the category of plants only. One, especially a taxonomist, may feel very much perturbed to see this plant species insensibly treated as an animal species and included in the taxonomic hierarchy of ECAT IndFauna, rendering it an accepted status under the family Tephritidae (Diptera : Insecta). The particular ECAT web page shows, at the top, the status of the scientific name as accepted/valid, and, at the same time, with impunity makes a volte-face at the page-end, suggesting that no taxonomic scrutiny is done on the name. The content of this web page turns out to be an absolute, absurd paradox when one simply clicks open the Google images, given at the base of the page, to know further about *E. jambolana*, making him/her baffle to see a vivid display of the Jamun plant.

Among the Indian fauna, the group 'butterflies' among 'insects' has got a unique status. It is revealed that the alpha taxonomy of the Indian butterflies is almost absolute, very much like that of avifauna of the country. One well-known genus *Papilio* (Rhopalocera : Lepidoptera : Insecta) has only a diversity of 21 species so far reported or documented from the whole Indian Region (Wynter-Blyth, 1957) and the most recent estimate of the species diversity, of the whole family Papilionidae, comprising 10 genera, including the genus *Papilio*, realized from India is only 107 species (Kunte, 2000). It is beyond comprehension as to how ECAT database, with an avowed scientific prudence, was able to incorporate into itself with as many as 207 species of the genus *Papilio*, rendered with accepted/valid scientific names, in India. There is no point in projecting this error factor in percentages, here.

Yet another revealing example of error is that of a very common dragonfly species, *Orthetrum sabina sabina* (Drury) of the family Libellulidae (Odonata : Insecta), which is listed four times (twice in each of binomial and trinomial name codes) in the category of accepted/valid scientific names of taxa in IndFauna database.

This sort of flaw is not confined to the enumeration of valid taxa of insects or invertebrates alone; it permeates to the treatment of taxa of taxonomically well-documented vertebrate groups too.

Among the freshwater fishes of the genus *Garra* (Cyprinidae : Cypriniformes) known from India, the namé *Garra jenkinsonianum* Hora no longer identifies itself with a valid taxon, but only as one among the synonyms, of the species with the currently valid scientific name *Garra mullya* (Sykes). It is rightly presented so in the ECAT web page, under the accepted/valid scientific name of the species *G. mullya* (listed with *G. jenkinsonianum* as a synonym of it). But, just trivializing the scientific merit of this entry, the *G. jenkinsonianum* again reflects as an accepted/valid scientific name, in the category of the scientific names of the valid species of the genus *Garra*.

It is very difficult to understand that this kind of a taxonomic database, with an array of scientific names of taxa in aberrant order (not in conformity with the principles of taxonomy and systematics), is a work-in-progress system that is dynamic. Chavan *et al.* (2005) have remarked that developing ECAT is an ongoing, 'work-in-progress' system that is dynamic in nature. It is true; nobody denies it. But, when an operational system of taxonomic work is said to be dynamic, what one would perceive about it ? A straight talk seems to be very expedient in this regard to clear out confusion on certain aspects.

The subject Taxonomy/Systematics itself is a dynamic science, why because the focal base unit of taxonomy, the 'taxon' has come into existence on a hypothetic consideration, not based on an everlasting, sustainable fact. It is the existing knowledge base, extensive or shallow, available on a taxonomic group that a taxonomic expert makes use while observing an array of characters of a specimen(s), sifting them in a discernibly appropriate manner, prior to describing a new taxon. Its flexibility gets revealed when another taxonomist convincingly arrives at yet different conclusions, using till-dated knowledge, rendering it a changed status. The swinging status of a taxon from its genesis to become, later perhaps, a mere synonym or an obsolete, or even, sometimes, a resurrected entity—all processes an inevitable part of the task—is what makes the subject taxonomy a dynamic science. It is this dynamic progress of the status of taxon/taxa, and, in turn, of the taxonomic hierarchy that should get imbibed and translated into a taxonomic cataloguing system, as and when required, that eventually earns the claim an up-to-date, accurate and authentic database. A catalogue of scientific names of taxa depicted with transposed names of genera and species of unrelated taxonomic groups, somewhat symbolizing the binomial system of nomenclature, is not a part of, or an evidence of, a dynamic database work in taxonomy, but only a mere mockery of the same.

Now, with an online appeal, seemingly a turning-point claim has come out in the IndFauna web site, regarding the completion of the compilation of baseline information for over 90,000 known species. This ambitious effort was, according to the database makers, apparently in a self-congratulatory mode, the culmination of an intensive activity taking "20 man years spread over two and half years" Indeed a stupendous achievement, a feat that could not be achieved fully even by the systematists in the developed nations !

But, ironically, a notion of anticlimax to this claim is also closely following, that the 'IndFauna' has collated the basic taxonomic information from over 7,800 sources of scientific literature of the past 100 + years, and extracted also data from several online checklists, to make a "dirty list" of species—to use the cliché of the term the 'IndFauna' database makers applied—to be scientifically sieved again by the taxonomists themselves.

ECAT system greatly benefits end users and policy makers. But such an impression about the programme stems from the end users only when the available data in the system is at least reasonably accurate, irrespective of being whether old or up-to-date. The point is that the database information should never have inherent flaws, in contradiction with the known data of the available knowledge in scientific literature. However, the ECAT of IndFauna is packed with innumerable absurdities of information pertaining to the Indian fauna, perhaps, because of careless imputation of available data into the web system, smarted with unusual haste and quest for attaining the absolute completion of the compilation work. IndFauna system, on one hand, claims a credit or an attribute of scientific precision and authenticity to the system, and quite abruptly, on the other hand, disowns its credibility by not guaranteeing to be reasonably flawless, facilitating confusion of an end user to draw firm scientific information or conclusions from it. As regards the utility and dependability of the ECAT database work to end users, the database makers should have born in mind, with a forethought, one proverb : *'the proof of pudding is in its eating'*

IndFauna database makers wonder why a 'similar exercise' was not initiated before. There is enough euphemism implied in it, as veiled criticism, aimed at the country's premier institutions dealing with biodiversity research. The doubt is partly answered by certain just and bare facts—not mere 'arguments', so perceived by IndFauna makers—such as lack of resources, manpower and standardized procedures. Even then, the delusion on the part of ECAT makers needs to be cleared further. The taxonomists, rather the institutions, such as ZSI or BSI, and perhaps other biodiversity research bodies, know well about the nuances or subtleties of making a unitary, taxonomic cataloguing system—textual (off-line) or electronic (on-line)—linking mega-meta-taxonomic databases of dispersed information, strictly based on the international codes of zoological, botanical nomenclature. These institutions may not simply embark upon a short-term venture of that magnitude with the existing infirmities. Hence these institutions do keep a restraint on initiating such ambitious project, and, instead, run or take the risk of providing the biodiversity information on certain selected taxonomic categories or groups upon which they are at a premium, acquired with quality data of scientific precision and authenticity.

Yet again, taxonomists, very limited in number now-a-days, are preoccupied with their primary roles of describing/inventorying taxa and updating the information through periodic review/ revisionary work of groups related to their taxonomic expertise. For them, it is a pre-assigned path since a major chunk of living things, remaining as unknown asset of our biodiversity, needs to be

explored, detected and described. Added to that, when more and more newly described taxa are integrated to the hypothesis-driven, dynamic science of taxonomy, it becomes too heavier a task for the small lot of taxonomists available in the country to handle and manage the unitary, indexing/cataloguing work, encompassing the whole known biodiversity. Besides, consensus among them is an imperative necessity, which plays a critical role imparting consistency and continuity to such a dynamic process of taxonomic work. It requires a collective, collaborated joined action of a larger network of taxonomic experts, reposed with trust and confidence among themselves.

A centralized unitary on-line catalogue of species, encompassing all-known taxa of the country, is not unachievable, but not so soon as sometimes wrongly perceived under some delusion. The documentation processes that are going on, independently, on selected taxonomic categories would certainly be transmuted to become a part of a functional continuum process towards the ultimate goal of a unitary biodiversity information system later, perhaps much sooner, once necessary support links are ensured to taxonomic research in the country. Otherwise, the 'similar exercise', of what ECAT IndFauna makers have done and achieved, could only gain or earn the claim and credit, nothing less than, of being a crass cataloguing work, comprising only supposedly authenticated 'dirty list' of species.

As members of taxonomic fraternity, we have cited certain ills/crucial flaws that beset the instantly accessible ECAT database of IndFauna. Our impressions upon the ECAT database are not just impulsive remarks or a mark of spiteful approach from taxonomists in general. The database makers should see the facts clearly and try to get rid of the errors/perils that have crept into the ECAT IndFauna work. The IndFauna makers take a stand that even the global ECATs like 'ITIS' is not free from the lapse of lacking a thorough scrutiny, which is in no way a justification for the flaws in their database, make up. It must be realized that those database banks seldom reflect the kind of errors and flaws as that found in the ECAT registry of names of IndFauna. More over, such flaws are out of context when the taxonomic hierarchy of species, with the valid/accepted scientific names, followed in ECAT IndFauna system, is claimed to have matched with the standards of ITIS, and as well referred to with International Code of Zoological Nomenclature.

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