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# WETLAND FAUNAL RESOURCES OF WEST BENGAL–4. DARJILING AND JALPAIGURI DISTRICTS

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## INTRODUCTION

During 1996–97 and 1997–98, two surveys were undertaken to study wetland faunal resources of Darjiling and Jalpaiguri districts, representing the fourth report in the series. The significance of this survey lies with the fact that Darjiling and Jalpaiguri districts represent the hills and the terai-duars regions respectively. The narrow winding gorges of mighty rivers in the majestic Himalayan ranges run down the duars region forming marshy swamps along the valleys and the terai plains. The wetland habitats of duars region particularly of Jaldapara Wildlife Sanctuary of Jalpaiguri district are the abode of wild animals (Spillet, 1967). But, game animal is usually rare in wetland environs of Darjiling district.

Studies on faunal resources of wetlands in West Bengal mostly pertain to Calcutta and its adjoining districts of South Bengal (De *et al.*, 1989; Ghosh, 1990; Nandi *et al.*, 1993, 1999, 2001a, b). Very little is known on wetland fauna of North Bengal except the study on trophic structure and physical characteristics of some lentic habitats by Dasgupta (1995). Largely for this reason the present study was undertaken from Darjiling and Jalpaiguri districts representing the hills and the terai-duars region of North Bengal.

## THE STUDY AREA

***General*** : The districts of Darjiling and Jalpaiguri fall under the broad physiographic division, the Himalayan and sub-Himalayan West Bengal. Darjiling district, excluding a major portion of Siliguri subdivision, lies on the Himalayan hill. Jalpaiguri district mostly represents the plains (some 90 m above the sea level) with a belt of forest; the portion lying west of Teesta river is known as the "Terai" and the portion lying east of the river is known as "Duars" This forest belt in the past was very dense and was full of swamps. The duars, criss-crossed with mountain rivers,

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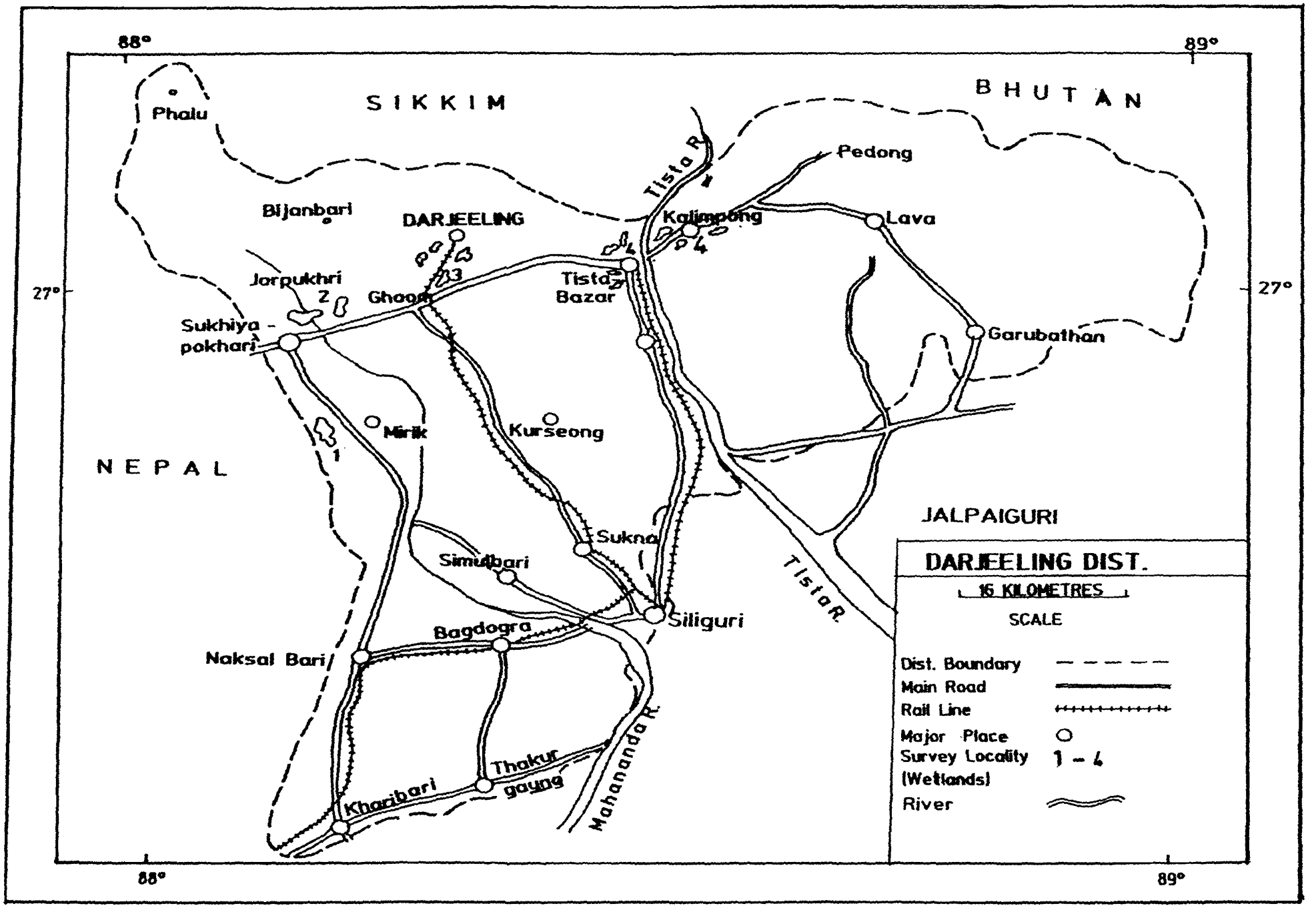


Fig. 1. : Map of Darjeeling district showing the wetlands (1–4) surveyed. 1 = Mirik Lake; 2 = Ponds and ditches of Jorpukhi Salamander Sanctuary; 3 = Ponds and jhoras of Darjeeling-Ghoom areas; 4 = Ponds and jhoras of Teesta-Kalimpong areas.

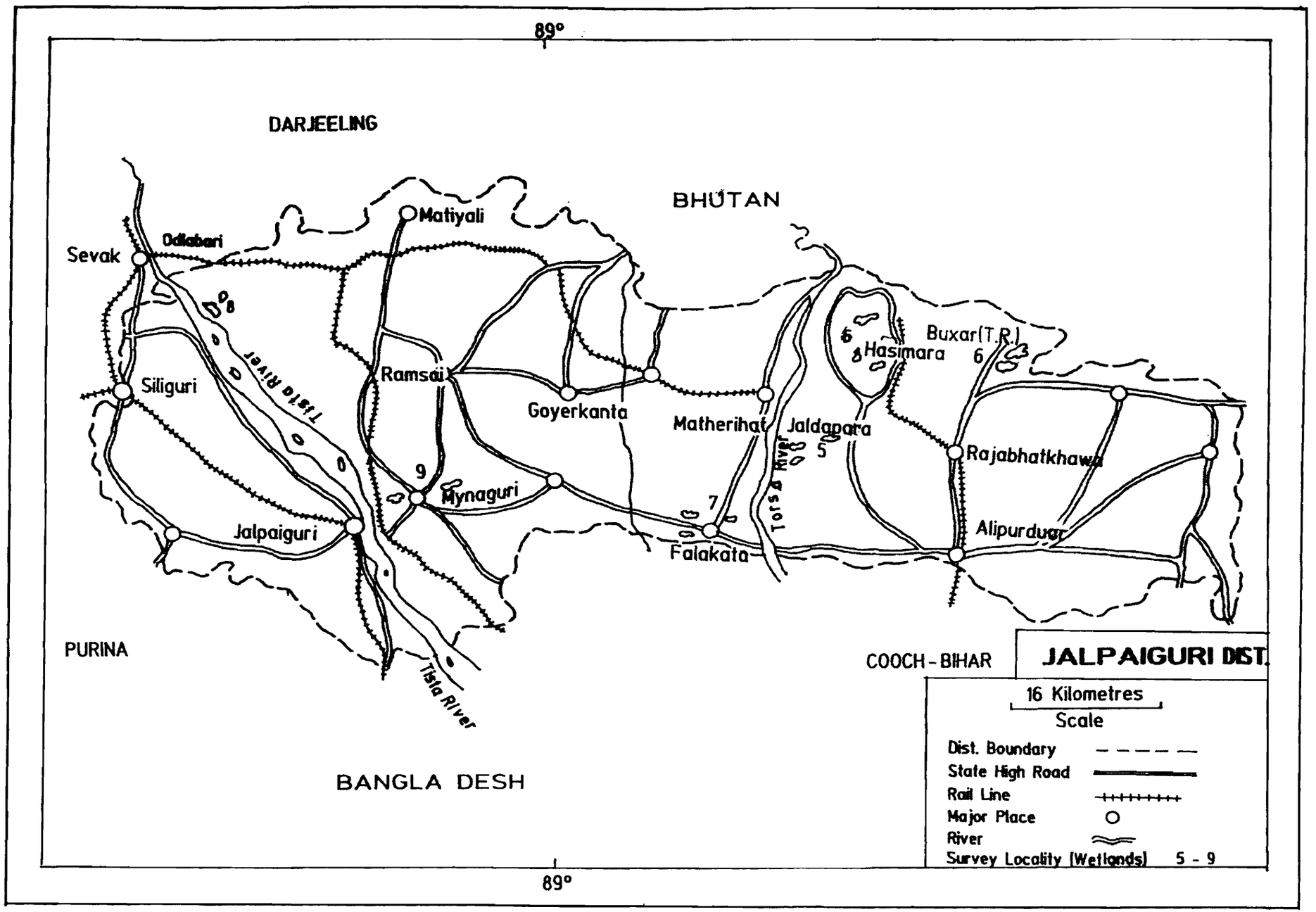


**Fig. 2.** : Map of Jalpaiguri district showing the wetlands (5–9) surveyed. 5 = Ponds, river and swamp in and around Jaldapara Wild Life Sanctuary; 6 = Ponds and lake in and around Buxa Tiger Reserve; 7 = Ponds and wetlands of Falakata area; 8 = Kathambari beel; 9 = Ponds and fishery of Paharpur-Mainaguri areas.

mostly support swamps of the sub-Himalayan region. Darjiling district lies between 26°27' and 27°13' N latitude; and 27°59' and 88°53' E longitude at the northern part of West Bengal covering a geographical area of 3254 sq. km. The major part of the district is in the Himalayan ranges extending over an elevation of 200 to 3800 m, with temperature reaching below the freezing point in winter (Banerji *et al.*, 1980). The mean maximum and mean minimum temperature during winter are 8.3°C and 1.6°C and the same during the hottest period is 18.9°C and 14.5°C respectively. The mean temperature varies from 10.2–16.7°C, some areas experience temperatures below 0°C every year. Monsoon season extends from June to September with average annual rainfall 2812 mm. The thunderstorms generally occur between March and June. The main rivers are Teesta and Mahananda. The forest is mixed type from riverine to Ook-Hemlock forests. The vegetation cover is 46.2% of which 29.63% dense forest, 11.8% open forest, and the rest plantations.

Jalpaiguri district (26°16'–27°0' N and 88°0'–89°53' E) lies in the moist tropical zone with an area of 6227 sq. km. (Kusari *et al.*, 1981). The total forested area is 23.5% out of which 13.26%, 5.9% and 4.37% are dense, open and plantation forests respectively. The important reserve forests, like Jaldapara, Buxa, Gorumara and Chapramari are located in this district. The average day temperature varies from 15.5–32°C and the average rainfall varies from 4100–5000 mm. Thunder and hailstorms are frequent between April and September. The main rivers are Rydak, Jaldhaka, Torsa, Kaljani, Dhawls. The district is rich in both plant and animal bio-diversity where a large number of species are endemic to the area. The species diversity of mammals is comparatively highest in Buxa Tiger reserve (71 species) among the Tiger reserves in India (Anonymous, 1995).

The physiographic features including population figures of these two districts are given in Table 1.

**Table 1.** : Physiographical features of Darjiling and Jalpaiguri districts, West Bengal.

| Parameters | Darjiling district | Jalpaiguri district |
|---|---|---|
| Area (in sq. km.) | 3,149 | 6,227 |
| Altitude | 40–3630 m | 75–150 m |
| Latitude | 26°31'–27°13' N | 26°16'–27°00' N |
| Longitude | 87°59'–88°53' E | 88°4'–89°53' E |
| Population (2001 census) | 16,05,900 | 34,03,204 |
| Population density (sq. km.) | 510 | 547 |
| Temperature (°C) | 4.5–18.9 | 12.2–40 |
| Rainfall | 321 cm | 390 cm |
| Humidity | 70–90% | 80–90% |
| Landscape type | Himalayan mountains | Terai-Duars plains |
| Soil type | Mountain soil | New alluvial soil |
| Vegetation type | Tropical evergree / deciduous | Tropical evergree / deciduous |
| Forest cover (in sq. km.) | 12.46 | 1456 |
| Water resource (in ha) | 4763.51 | 17073.11 |

***Soil*** : At the foot of the Himalayas, the soils are mostly sandy, raw humus type, and deep black to grey-black in colour. These represent the rice growing areas of Jalpaiguri district, which get waterlogged during rain. The soil is acidic, the pH ranging from 4.7 to 5.8. In Jalpaiguri district, in general, the soil is alluvium, ranging from pure sand to clay but generally sandy loam. In Darjiling district, the soil of the terai tract is alluvium of light sandy loam in texture. A kind of red soil is found in patches of areas lying in Kalimpong and Gorubathan Police Stations of Darjiling district. A small portion of the hill soil consists of stiff loam of reddish colour. In general, the soils are poor in lime contents (Raychaudhuri *et al.*, 1963).

***Vegetation*** : The common hydrophytes that occur in the wetlands of Jalpaiguri district include species belonging to the genera *Nymphaea, Nymphoides, Jussiaea, Hydrolea, Ipomoea, Limnophila, Hydrilla, Ottelia, Monochoria, Pistia, Lemma, Sagittaria, Alisma, Najas, Scirpus, Marselia, Eichhorma, Azolla, etc.* (Kusari *et al.*, 1981). In the Mirik Lake of Darjiling district reeds (*Typha*) and sedges (*Cyperus* spp.) have been noted. The riverine habitat of Jaldapara Wildlife Sanctuary of Jalpaiguri district consists primarily of forests with tall, dense grasses and interconnecting waterways. Being flooded each year by the rivers flowing through the sanctuary, much of the grassland or sandy soils is colonized primarily by a relatively short grass, *Saccharum spontaneum*, which is usually less than six feet high. *Phragmites karka* is generally found in clay pockets, as is *Saccharum procerum.* Some other grasses present in the sanctuary are *Erianthus elephantinus, Anthistria giganiea, Andropogon nardus, Arundinella brasiliensis, Arundo donax, Paspalidium punctatum, Saciolepis myosuroides, etc.* (Spillett, 1966).

***Water resource*** : The major rivers of the Darjiling Himalaya are Teesta, Mahananda and Jaldhaka. The major tributaries of the Teesta are Rangit, Rangpo, Rili, Sebak, etc., while that of Mahananda river are Balasan and Mechi rivers. The Darjiling Himalaya region exhibits many beautiful springs and waterfalls besides ponds and jheels. The undulating Terai-Duars plains are traversed by Mechi, Mahananda, Teesta, Jaldhaka, Torsa, Kaljani, Raidhak and Sankosh rivers. The behaviour of these rivers is always unpredictable. They have a tendency to cut new channels during the annual flood season, from May to September and interconnected by a network of "cross-country" watercourses. The frequent changes in the river course result in numerous pools and marshes in the terai-duars region.

## MATERIAL AND METHODS

A total of 15 freshwater wetlands, 6 from Darjiling and 9 from Jalpaiguri district, comprising of ponds, beels lakes, fishery system and road-wide nullahs were surveyed twice during the years 1996 and 1997. Both ponds and roadside nullahs (ponds) were clustered herein to show their faunal element, lake/locality-wise for convenience as follows :

Darjiling District :
1. Mirik Lake
2. Ponds and ditches of Jorpukhri Salamander Sanctuary
3. Ponds and jhoras Darjiling-Ghoom areas
4. Ponds and jhoras Teesta-Kalimpong areas

Jalpaiguri District :
5. Ponds, river and swamp in and around Jaldapara Wildlife Sanctuary
6. Ponds and lake in and around Buxa Tiger Reserve
7. Ponds and wetlands of Falakata area
8. Kathambari beel
9. Ponds and fishery of Paharpur-Mainaguri areas.

Both the surveys were conducted during September-October months. The geographical locations of nine-selected wetland areas are shown in Fig. 1 & 2, indicating serial number as above. Field observations as well as some environmental parameters were noted. Faunal samples of zooplankton, macroinvertebrate, fishes and amphibians were collected using plankton net, drag net, cast net, etc. Higher vertebrates and cultivable fishes were observed in the field. Local enquiries were made to ascertain the occurrence of some important vertebrate species in the field. The faunal elements inhabiting the selected wetlands are presented in the following text and Tables 2–8 indicating their occurrence under Darjiling and Jalpaiguri districts in parenthesis as per serial number given above.

## FAUNAL RESOURCES

Darjiling and Jalpaiguri districts are rich in faunal diversity in their terrestrial and arboreal habitats. But they are not so rich in wetlands as well as wetland fauna. The faunal elements habitually found to inhabit wetlands include aquatic, wetland dependent and wetland associated species (Nandi *et al.*, 1993). However, mention has also been made about some important dryland vertebrate species either common or occasional but characteristic to the area protected as sanctuary/reserve, viz., Jaldapara Wildlife Sanctuary and Buxa Tiger Reserve harbouring wetlands within these two protected areas.

## VERTEBRATES

**Mammals** : Six species of mammals viz., the Smooth Indian Otter, *Lutra perspicillata*, the Great One-horned Rhinoceros, *Rhinoceros unicornis*, Wild Boar, *Sus scrofa*, Fishing Cat, *Felis viverrina*, Wild Buffalo, *Bubalus bubalis* and Swamp Deer, *Cervus duvauceli* have been associated with wetlands of Jalpaiguri district only. Of these, Smooth Otter and Fishing Cat occur in Kathambari beel, while Fishing Cat and Swamp Deer inhabit wetlands of Buxa Tiger Reserve. The swamp of Jaldapara Wildlife Sanctuary offers suitable living conditions to four wetland dependent mammals

**Table 2.** : List of avian species recorded in wetlands of Darjiling and Jalpaiguri districts.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Darjiling district* | *Jalpaiguri district* |
| A. **Resident birds** | | |
| Family PODICEPETIDAE | | |
| *Podiceps ruficollis* (Pallas) | – | 7, 8 |
| Family PHALACROCORACIDAE | | |
| *Phalacrocorax niger* (Vicillot) | – | 5, 7–9 |
| *Anhinga rufa* (Daudin) | – | 8 |
| Family ARDEIDAE | | |
| *Ardea purpurea* Linnaeus | – | 5, 6, 8 |
| *Ardea alba* J. E. Gray | – | 5–8 |
| *Ardeola grayii* (Sykes) | – | 5–9 |
| *Bubulcus ibis* (Boddaert) | – | 5–9 |
| *Egretta garzetta* (Linnaeus) | – | 5–9 |
| *Ixobrychus cinnamomeus* (Gmelin) | – | 5, 7, 8 |
| Family CICONIIDAE | | |
| *Anastomus oscitans* (Boddaert) | – | 5, 7, 8 |
| Family RALLIDAE | | |
| *Amaurornis phoenicurus* (Pennant) | – | 5–9 |
| *Porphyrio porphyrio* (Linnaeus) | – | 5–8 |
| *Gallinula chloropus* (Linnaeus) | – | 5–8 |
| Family JACANIDAE | | |
| *Hydrophasianus chirurgus* (Scopoli) | – | 5–9 |
| Family ROSTRATULIDAE | | |
| *Rostratula bengalensis* (Linnaeus) | – | 7, 8 |
| Family CHARADRIIDAE | | |
| *Hoplopterus indicus* (Boddaert) | – | 5–8 |
| Family ALCEDINIDAE | | |
| *Ceryle rudis* (Linnaeus) | 1 | 5–9 |
| *Alcedo atthis* (Linnaeus) | 1 | 5–9 |
| *Pelargopsis capensis* (Linnaeus) | – | 5, 6 |
| *Halcyon smyrnensis* (Linnaeus) | 1 | 5–9 |

**Table 3.** : List of reptilian species recorded in wetlands of Darjiling and Jalpaiguri districts.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Darjiling district* | *Jalpaiguri district* |
| Family EMYDIDAE | | |
| *Kachuga tecta* (Gray)<br>Indian Sawback Turtle | – | 7 |
| Family TRIONYNICHIDAE | | |
| *Lissemys punctata* (Bonaterre)<br>Indian Flap-shelled Turtle | – | 5–9 |
| Family VARANIDAE | | |
| *Varanus bengalensis* (Daudin)<br>Bengal Monitor | 1, 2 | 5–9 |
| Family BOIDAE | | |
| *Python molurus* (Linnaeus)<br>Indian Rock Python | – | 5, 6 |
| Family COLUBRIDAE | | |
| *Enhydris enhydris* (Schneider)<br>Smooth Water Snake | – | 7–9 |
| *Xenochrophis piscator*<br>Checkered Keelback | – | 7–9 |

**Table 4.** : List of amphibian species recorded in wetlands of Darjiling and Jalpaiguri districts.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Darjiling district* | *Jalpaiguri district* |
| Family BUFONIDAE | | |
| *Bufo melanostictus* Schneider<br>Common Indian Toad | 1–4 | 5–9 |
| *Bufo himalayana* Gunther | 1 | – |
| Family MICROHYLIDAE | | |
| *Microhyla ornata* (Dumeril and Bibron)<br>Ornate Frog | 1 | 5, 7 |
| Family RANIDAE | | |
| *Rana cyanophlyctis* Schneider<br>Skipping Frog | 1, 2 | 5–9 |
| *Rana limnocharis* Boie<br>Cricket Frog | 1, 2 | 5–9 |
| *Rana tigrina* Daudin<br>Indian Bull Frog | 1 | 5–9 |
| Family SALAMANDRIDAE | | |
| *Pleurodeles verrucosus* (Anderson)<br>Himalayan Newt | 1, 2 | – |

**Table 5.** : List of fishes occurring in wetlands of Darjiling and Jalpaiguri districts.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Darjiling district* | *Jalpaiguri district* |
| Family NOTOPTERIDAE | | |
| *Notopterus notopterus* (Pallas) | – | 5–9 |
| Family CYPRINIDAE | | |
| *Salmostoma bacaila* (Hamilton) | – | 5, 6, 8 |
| *Hypophthalamichthys molitrix* (Valenciennes) | 1 | 5, 7, 9 |
| *Aspidoparia morar* (Hamilton) | – | 5, 6 |
| *Amblypharyngodon mola* (Hamilton) | – | 5–9 |
| *Barilius bendelisis* Hamilton | 1, 4 | 5, 6 |
| *Danio aequipinnatus* (McClelland) | 1, 4 | 5, 6 |
| *Danio devario* (Hamilton) | 1, 4 | 5, 6 |
| *Danio rerio* (Hamilton) | 1 | 5–9 |
| *Esomus danrica* (Hamilton) | – | 5–9 |
| *Rasbora daniconius* (Hamilton) | – | 5–9 |
| *Catla catla* (Hamilton) | 1, 4 | 5–9 |
| *Cirrhinus mrigala* (Hamilton) | 1, 4 | 5–9 |
| *Cyprinus carpio* Linnaeus | 1, 4 | 5–9 |
| *Ctenopharyngodon idella* (Valenciennes) | 1, 4 | 5–9 |
| *Labeo rohita* (Hamilton) | 1, 4 | 5–8 |
| *Labeo boga* (Hamilton) | 1 | 5–8 |
| *Labeo gonius* (Hamilton) | 1 | 5 |
| *Osteobrama cotio* (Hamilton) | – | 5–8 |
| *Puntius chola* (Hamilton) | 1, 4 | 5–9 |
| *Puntius conchonius* (Hamilton) | 1 | 5–9 |
| *Puntius phutunio* (Hamilton) | – | 5–9 |
| *Puntius sophore* (Hamilton) | – | 5–9 |
| *Puntius ticto* (Hamilton) | 1, 4 | 5, 6 |
| *Tor putitora* (Hamilton) | – | 5, 6 |
| *Garra annandalei* Hora | 1 | 5, 6 |
| *Garra gotyla* (Gray) | 1, 4 | 5, 6 |
| Family HOMALOPTERIDAE | | |
| *Nemacheilus botia* (Hamilton) | 1 | 5, 6 |
| *Nemacheilus corica* (Hamilton) | 1 | 5, 6 |
| *Nemacheilus rupicola* (McClelland) | 1, 4 | 5, 6 |

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

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | ***Darjiling district*** | ***Jalpaiguri district*** |
| Family COBITIDAE | | |
| *Lepidocephalus guntea* (Hamilton) | 1 | 5–9 |
| Family BAGRIDAE | | |
| *Batasio batasio* (Hamilton) | – | 5, 6 |
| *Mystus vittatus* (Bloch) | – | 5–9 |
| *Mystus tengara* (Hamilton) | – | 5, 6 |
| Family SILURIDAE | | |
| *Ompak bimaculatus* (Bloch) | – | 5, 6 |
| *Wallago attu* (Schneider) | – | 5, 6 |
| Family CLARIIDAE | | |
| *Clarias batrachus* (Linnaeus) | 1 | 5–9 |
| Family HETEROPNEUSTIDAE | | |
| *Heteropneustes fossilis* (Bloch) | 1 | 5–9 |
| Family CYPRINODONTIDAE | | |
| *Aplocheilus panchax* (Hamilton) | 1, 3, 4 | 5–9 |
| Family CHANNIDAE | | |
| *Channa barca* (Hamilton) | – | 5, 8 |
| *Channa striatus* (Bloch) | 1 | 5–9 |
| *Channa orientalis* (Schneider) | – | 5–9 |
| *Channa punctatus* (Bloch) | 1 | 5–9 |
| Family SYMBRANCHIDAE | | |
| *Monopterus cuchia* (Hamilton) | 1 | 5–9 |
| Family CHANDIDAE | | |
| *Chanda nama* Hamilton | 1 | 5–9 |
| *Chanda ranga* Hamilton | 1 | 5–9 |
| Family NANDIDAE | | |
| *Badis badis* (Hamilton) | – | 5–9 |
| *Nandus nandus* (Hamilton) | – | 5–9 |
| Family CICHLIDAE | | |
| *Oreochromis mossambica* (Peters) | – | 5, 9 |
| Family MASTACEMBELIDAE | | |
| *Mastacembelus armatus* (Lacepede) | – | 5, 7, 8 |
| *Mastacembelus pancalus* (Hamilton) | – | 5–9 |
| **Total (= 54 species)** | **20** | **54** |

**Table 6.** : List of macroinvertebrates recorded in wetlands of Darjiling and Jalpaiguri districts. West Bengal.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Jalpaiguri district* | *Darjiling district* |
| A. **Macrocrustaccans (Decapoda)** | | |
| Family PALAEMONIDAE | | |
| *Macrobrachium rude* (Heller) | – | 5 |
| *Macrobrachium rosenbergii* (deMan) | – | 7–9 |
| *Macrobrachium lamarrei* (H. M Edwards) | – | 6–9 |
| *Macrobrachium* sp. | – | 5, 7, 9 |
| *Palaemon styliferus* Milne Edwards | – | 5–9 |
| Family POTAMONIDAE | | |
| *Sartoriana spinigera* Wood Masoon | – | 5–9 |
| *Potamon* sp. | 1, 3 | – |
| B. **Insects** | | |
| INSECTA : HEMIPTERA | | |
| Family BELOSTOMIDAE | | |
| *Diplonychus rusticum* (Fabricius) | 1, 2 | 5–9 |
| *Diplonychus annulatus* (Fabricius) | 1, 2 | 5–9 |
| *Diplonychus molestum* (Dufour) | – | 5, 7 |
| *Diplonychus* sp. | – | 9 |
| *Lethocercus indicus* (Lep. & Serv.) | – | 7–9 |
| Family NEPIDAE | | |
| *Laccotrephes ruber* (Linnaeus) | – | 6 |
| *Laccotrephes griseus* (Guerin) | 1, 2 | 5–9 |
| *Laccotrephes* sp. | – | 7 |
| *Ranatra sordidula* Dohrn | 1, 2 | 6, 7, 9 |
| *Ranatra filiformis* Faabricius | 1, 2 | 5–9 |
| *Ranatra longipes* Stal | – | 5 |
| *Ranatra varipes* Stal | – | 5 |
| *Ranatra* sp. | – | 7 |
| Family CORIXIDAE | | |
| *Corixa* sp. | 1–4 | 5–9 |
| *Micronecta* spp. (3 species) | 1, 3, 4 | 5–9 |

**Table 6.** : *(Cont'd.).*

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Jalpaiguri district* | *Darjiling district* |
| Family NOTONECTIDAE | | |
| *Anisops* spp. (3 species) | 1–4 | 5–9 |
| Family MESOVELIDAE | | |
| *Mesovelia vittigera* Horvah | 1, 4 | 5–9 |
| Family HYDROMETRIDAE | | |
| *Hydrometra* sp. | 1 | 5–7, 9 |
| Family GERRIDAE | | |
| *Gerris* spp. (2 species) | 1, 2, 4 | 5–9 |
| *Limnogonus fossarum* (Fabricius) | – | 5, 7 |
| *Limnogonus nitidus* (Mayr) | 2 | 7–9 |
| *Limnogonus parvulus* (Stal) | 1, 2 | 6, 9 |
| *Rhagadotarsus kraepelini* Breddin | – | 5, 8 |
| Family PLEIDAE | | |
| *Plea* spp. (2 species) | 1 | 5–9 |
| INSECTA : COLEOPTERA | | |
| Family DYTISCIDAE | | |
| *Guignotus signatellus* Klug | – | 5 |
| *Hydrovatus* sp. | – | 5, 6, 9 |
| *Rhantus taprobanicus* Sharp | 2, 3 | – |
| *Platynects* sp. | 3 | – |
| *Agabus* sp. | 2 | – |
| *Cybister* sp. | – | 5, 8 |
| Family HYDROPHILIDAE | | |
| *Regimbartia attenuata* F. | 1 | 6–9 |
| *Sternolophus rufipes* F. | – | 6, 7, 9 |
| *Berosus indicus* Mots. | 2 | 6–8 |
| *Helochares* sp. | – | 7, 8 |
| *Amphiops* sp. | | |
| INSECTA : ODONATA | | |
| Family LIBELLULIDAE | | |
| *Urothemis* sp. | 2 | 6, 8 |
| *Brachythemis* sp. | 1, 2 | 6, 8 |
| *Anax* sp. | – | 7, 8 |

**Table 6.** : *(Cont'd.).*

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Jalpaiguri district* | *Darjiling district* |
| Family COENAGRIONIDAE | | |
| *Enallagma* sp. | 2 | 5–9 |
| INSECTA : EPHEMEROPTERA | | |
| Family CAENIDAE | | |
| *Caenis* sp. | 3 | 6, 7 |
| Family BAETIDAE | | |
| *Cloeon* sp. | 3, 4 | 6, 7 |
| INSECTA : DIPTERA | | |
| Family CULICIDAE | | |
| *Culex* sp. | 1, 2 | 5–9 |
| *Anopheles* spp. (2 species) | 2 | 5–9 |
| Family CHIRONOMIDAE | | |
| Chironomid larvae (2 species) | 1 | 7–9 |
| INSECTA : ORTHOPTERA | | |
| Family GRYLLOTALPIDAE | | |
| *Gryllotalpa africana* Beauvois | 1 | 7 |
| C. **Arachnids** | | |
| Family LYCOSIDAE | | |
| *Lycosa* sp. | 3 | 5, 8 |
| *Pardosa* sp. | 2 | 6, 7, 9 |
| Family TETRAGNATHIDAE | | |
| *Tetragnatha* spp. (2 species) | – | 6–9 |
| Order ACARINA | | |
| *Water mites* | 1, 3 | 6–9 |
| D. **Annelids** | | |
| Family TUBIFICIDAE | | |
| *Limnodrilus* sp. | 1 | – |

**Table 6.** : *(Cont'd.).*

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | ***Jalpaiguri district*** | ***Darjiling district*** |
| Family HAEMADIPSIDAE | | |
| *Haemadipsa* sp. | 1, 2, 3 | – |
| Family GLOSSIPHONIDAE | | |
| *Glossiphonia* sp. | 1, 2 | 7, 8 |
| E. **Molluscs** | | |
| MOLLUSCA : GASTROPODA | | |
| Family THIARIDAE | | |
| *Thiara tuberculata* (Muller) | – | 5–7 |
| *Thiara lineata* (Gray) | – | 5, 6 |
| *Paludomus regulata* (Benson) | – | 7 |
| *Brotia costula* (Rafinesquc) | – | 6 |
| Family VIVIPARIDAE | | |
| *Belamya bengalensis* (Lamarck) | – | 5–9 |
| Family PILIDAE | | |
| *Pila globosa* (Swainson) | – | 5–9 |
| Family BITHYNIDAE | | |
| *Digonistoma pulchella* (Benson) | – | 5–7, 9 |
| Family PLANORBIDAE | | |
| *Indoplanorbis exustus* (Deshayes) | – | 5–9 |
| *Gyraulus convexiusculus* (Hutton) | – | 5–7, 9 |
| Family LYMNAEIDAE | | |
| *Lymnaea acuminata* Lamarck | – | 5–9 |
| *Lymnaea luteola* Lamarck | – | 7, 9 |
| MOLLUSCA : BIVALVIA | | |
| Family UNIONIDAE | | |
| *Lamellidens marginalis* (Lamarck) | – | 6 |
| Family Amblenidae | | |
| *Parreysia* sp. | – | 6 |
| **Total (= 82 species)** | **43** | **76** |

**Table 7.** : List of zooplankton species recorded in wetlands of Darjiling and Jalpaiguri districts. West Bengal.

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | *Darjiling district* | *Jalpaiguri district* |
| **CRUSTACEA : COPEPODA** | | |
| Family DIPTOMIDAE | | |
| *Diaptomus* sp. | – | 5–7 |
| Family CYCLOPIDAE | | |
| Mesocyclops spp. (2 species) | 1–3 | 5–7 |
| **CRUSTACEA : OSTRACODA** | | |
| Family CYPRIDIDAE | | |
| *Strandesia weberi* | – | 7 |
| *Astenocypris papyracea* (Sars) | – | 6 |
| Cyprid species | – | 5–7 |
| **CRUSTACEA : CLADOCERA** | | |
| Family SIDIDAE | | |
| *Diaphanosoma excisum* Sars | 1 | 5–7 |
| *Diaphanosoma sarsi* Richard | – | 6, 7 |
| *Latonopsis australis* Sars | – | 5, 6 |
| *Pseudosida bidentata* Herrick | – | 5 |
| Family DAPHNIIDAE | | |
| *Ceriodaphnia cornuta* Sars | – | 5 |
| *Daphnia pulex* Leydig | 2, 3 | – |
| *Scapholeberis kingi* Sars | – | 5, 6 |
| *Simocephalus vetulus* (O. F. Muller) | – | 5 |
| Family MOINIDAE | | |
| *Moinnadaphnia macleayi* (King) | – | 5 |
| Family MACROTHRICIDAE | | |
| *Bosmina longirostris* (O. F. Muller) | 1, 4 | – |
| *Grimaldina brazzai* Richard | – | 6 |
| *Guernella raphalis* Richard | – | 6 |
| *Hyocryptus spinifer* Herrick | – | 5, 6 |
| *Macrothrix laticornis* (Jurine) | – | 6 |
| *Macrothrix spinosa* King | – | 5–7 |
| *Macrothrix triserialis* (Brady) | – | 6 |

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

| Family and species | Occurrence in wetlands of | |
|---|---|---|
| | ***Darjiling district*** | ***Jalpaiguri district*** |
| Family CHYDORIDAE | | |
| *Alona costata* Sars | 1 | 6, 7 |
| *Alona davidi* Richard | – | 6 |
| *Alona guttata* Sars | 1 | – |
| *Alona karua* (King) | – | 5–7 |
| *Alona kwangensis* Chiang | – | 6 |
| *Alona pulchella* Sars | 1 | 5–7 |
| *Alona monacantha* (Stingelin) | – | 6 |
| *Alona reticulata* Sars | – | 5–7 |
| *Alonella excisa* (Fischer) | – | 5, 6 |
| *Chydorus barroisi* (Richard) | – | 6–7 |
| *Chydorus reticulatus* Daday | 1 | 5, 6 |
| *Chydorus sphaericus* (O. F. Muller) | 1 | 5–7 |
| *Dadaya macrops* (Daday) | – | 6 |
| *Dunhevedia crassa* King | – | 5, 6 |
| *Euryalona orientaslis* (Daday) | – | 6 |
| *Kurzia longirostris* (Daday) | – | 6 |
| *Notalona globulosa* (Daday) | – | 6 |
| *Oxyurella singalensis* (Daday) | – | 6 |
| *Pleuroxus similis* Vavra | – | 5 |
| *Pseudochydorous globosus* (Baird) | 2 | – |
| *Streblocerus serricaudatus* (Fischer) | – | 6 |
| **CRUSTACEA : CONCHOSTRACA** | | |
| Family CYCLESTHERIDAE | | |
| *Cyclestheria hislopi* Baird | – | 5, 6 |
| **CRUSTACEA : ROTIFERA** | | |
| Family ASPLANCHIDAE | | |
| *Asplancha* sp. | 1, 3 | 6 |
| Family FILINIDAE | | |
| *Filinia* sp. | 3 | – |
| **Total (= 45 species)** | **12** | **40** |

**Table 8.** : Comparative faunal diversity (major groups) of freshwater wetlands representing coastal plains. Gangetic plains and hills and terai regions, West Bengal.

| Major groups | Faunal diversity of | | | | |
|---|---|---|---|---|---|
| | *Coastal plains* | *Gangetic plains* | *Hills and Terai duars* | *Darjiling hills* | *Jalpaiguri duars* |
| Mammals | 3 | 1 | 6 | – | 6 |
| Birds | 67 | 54 | 20 | 3 | 20 |
| Reptiles | 6 | 6 | 6 | 1 | 6 |
| Amphibians | 6 | 6 | 7 | 6 | 5 |
| Fishes | 56 | 48 | 54 | 29 | 54 |
| Decapod crustaceans | 7 | 7 | 7 | 1 | 6 |
| Hemipterans | 20 | 27 | 30 | 19 | 30 |
| Coleopterans | 24 | 35 | 11 | 5 | 8 |
| Miscellaneous insects | Unknown | Unknown | 12 | 11 | 12 |
| Arachnids | 8 | 6 | 6 | 4 | 6 |
| Annelids | 9 | 6 | 3 | 3 | 1 |
| Molluscs | 12 | 15 | 13 | – | 13 |
| Zooplankton | 17 | 55 | 45 | 12 | 40 |
| **Total** | **235** | **286** | **220** | **94** | **207** |
| Source : | Nandi *et al.* (1993) | Nandi *et al.* (1999) | Nandi *et al.*, (present report) | | |

such as One-horned Rhinoceros, Wild Boar, Fishing Cat and Wild Buffalo. However, Jaldapara Wildlife Sanctuary is also known to harbour Indian Elephant, *Elephas maximus*; Pygmy Hog, *Sus salvanius*; Hog Deer, *Axis porcinus*; Bison, *Bos gaurus* and Hispid Hare, *Coprolagus hispidus* (Spillet, 1967; Ghose and Ghosal, 1985). Similarly, these mammalian species are also represented in and around riverine and lacustrine environments of Buxa Tiger Reserve. Besides these wetland associated species, the wetland habitats of these two forest reserves also harbour a number of carnivorous mammals such as Jackal (*Canis aureus*), Common Fox (*Vulpes bengalensis*), Sloth Bear (*Melursus ursinus*), Small Indian Civet (*Viverricula indica*), Palm Civet (*Paradoxurus hermaphroditus*), Jungle Cat (*Felis chaus*), Leopard Cat (*Felis bengalensis*), Leopard (*Panthera pardus*) and Tiger (*Panthera tigris*). In the Jaldapara Wildlife Sanctuary, the Tiger, *Panthera tigris* is more or less associated with swampy habitat like the mangrove swamps of Sanjnakhali Wildlife Sanctuary under Sundarban Biosphere Reserve (Saha *et al.*, 1992). However, Wroughton (1916) reported two species of water shrew, viz., *Nectogale elegans sikkimensis* de Winton & Styan and *Chimmarogale platycephala himalayana* (Grey) from Darjiling district.

**Birds** : Only 20 species of resident birds belonging to 9 families have been encountered in the wetlands of these two districts (Table 2). Being a hilly area, like wetlands, wetland birds of Darjiling district are poorly represented by three species of kingfishers encountered in Mirik Lake, even though the district contains nearly a quarter of all species of birds found in the Indian subcontinent (Lister, 1954). However, besides Eastern Goosander (*Mergus merganser orientalis*) and Barheaded Goose (*Anser indicus*) a variety of waterbirds viz., Great Whitebilled Heron (*Ardea imperialis*), Eastern Golden Plover (*Pluvialis dominicus fulvus*), Fantail Snipe (*Capella gallinago gallinago*), Pintail Snipe (*Capella stenura*) Wood Snipe (*Nemoricola n. nemoricola*), Painted Snipe (*Rostralua b. bengalensis*) etc., were reported from Terai region as well as Teesta and other rivers basins (Inglis, 1940). Jaldapara Wildlife Sanctuary is known to be inhabited by Pied Kingfisher (*Ceryle* sp.), Fishing Eagle (*Haliaetus* sp.), Cormorants (*Phalacrocorax* spp.), Cotton Teal (*Nettapus* sp.), Common Teal (*Anas* sp.), Grebe (*Podiceps* sp.) etc. Sanyal (1994) sighted Blacknecked Crane, *Grus nigricollis* Przevalski within the Bhutanghat forest core area of Buxa Tiger Reserve.

**Reptiles** : Six species of reptiles belonging to five families comprising of two species of turtles, one species of monitor lizard and three species of snakes have been found to occur in the selected wetlands of Darjiling and Jalpaiguri districts (Table 3). Two species of turtles and two species of colubrid snakes are aquatic, while the rest two reptilian species are wetland associated for shelter. Among the wetland associated species the common Indian Monitor, *Varanus bengalensis* is found by the side of nullah, marshes and ponds. The Indian Rock Python, *Python molurus* occurs around pools, marshes and streams. However, some other species of reptiles may be associated with wetlands as 17 species of lizards and 64 species of snakes are reported from these two districts (Ahmed and Dasgupta, 1992).

**Amphibians** : Seven species of toads, frogs and salamander newt belonging to four families, either aquatic or wetland dependent for their larval development, have been recorded (Table 4). Of these, three ranid frogs and the Himalayan Newt are aquatic species. The bufonid and microhylid are wetland dependent species usually found on moist shady places and also in and around wetlands during breeding season. All the three ranid species are more or less common in these two districts and occur in water on the banks of lakes, ponds and ditches. The Himalayan Newt, *Pleurodeles vrrucosus* inhabits seasonal and perennial pools of Jorpukhri Salamander Sanctuary as well as in the hillside pools/*jhoras* on the southern bank of Mirik Lake adjacent to Singha Devi Temple. Chanda (1986) described a new species *Rana senchalensis* from Senchal Lake, Darjiling. However, it is mentioned that 32 out of 39 anuran amphibians from West Bengal were recorded from Darjiling and Jalpaiguri districts (Sarkar *et al.*, 1992).

**Fishes** : Fifty-four taxa belonging to nineteen families have been recorded from various wetlands of Jalpaiguri district, while 33 species are determined from Darjiling district (Table 5).

Of the 19 families, the Family Cyprinidae is represented by 26 species which include major and minor carps belonging to genera *Labeo, Catla, Cirrhina* as well as Mahaseer (*Tor putitora*) and weed fishes (*Puntius, Esomus,* etc.). The various other groups of fishes are represented by catfishes (*Clarias, Heteropneustes, Wallago, Mystus, Batasio, Ompak*), murrels (*Channa* species) and mud ecls (*Mastacembelus* and *Monopterus* species). The species belonging to the genera *Garra* and *Nemacheilus* that are typically inhabiting running waters of the Himalayan hills, have been recorded from both the districts. These fishes possess suctorial disc formed on the lower lip, helping them to cling to the substratum as an adaptation to life in the fast flowing hill steams.

It is, however, mentioned that the species reported herein only represent a fraction of fish faunal diversity of the hills and terai region as Shaw and Shebbeare (1937) gave an account of 131 species belonging to 26 families and 8 orders from northern Bengal covering these two districts. Hora and Gupta (1941) added 2 species from Kalimpong Duars and Siliguri Terai region. Jayaram and Singh (1977) listed 96 species of which previous workers did not report 17 species.

## INVERTEBRATES

The aquatic invertebrate elements comprising of macro-invertebrates and zooplankton are reported herein mainly based on the specimens collected from the selected wetlands of these two districts.

**Macro-invertebrates** : Macroinvertebrates belonging to five major groups comprising of 76 species have been identified from freshwater wetlands of Darjiling and Jalpaiguri districts (Table 6). Of the five groups, namely, macrocrustaceans, insects, arachnids, annelids and molluscs, insects were found to dominate these wetlands.

**Macrocrustaceans** : Seven species of macrocrustaceans belonging to two families have been recorded from wetlands of Darjiling and Jalpaiguri districts. Of these, only one species of potamonid crabs viz., *Potamon* sp. was recorded from Darjiling district, while the rest six species were collected/ observed from wetlands of Jalpaiguri district.

**Insects** : A total of 53 species of insects belonging to 6 orders and 17 families have been observed/obtained from wetlands of these two districts. Among these, 41 species of aquatic adult insects belong to the orders Hemiptera (30 species) and Coleoptera (11 species), 11 species of aquatic larval forms representing orders Odonata (4 species) and Diptera (5 species), two species of nymphs, just emerged (Order : Ephemeroptera) and a single species of wetland associated gryllotalpid, *Gryllotalpa africana* (Order : Orthoptera) have been identified. Of the six insect orders, Hemiptera represents the highest diversity of 30 species followed by Coleoptera (11 species) and Diptera (5 species).

As per records in the Fauna of West Bengal, it is revealed that Bal and Basu (1994a) reported 14 and 4 species of aquatic and semi-aquatic Hemiptera from Darjiling and Jalpaiguri districts respectively. Bal and Basu (1994b) in another paper recorded 10 species of hemipteran insects from Darjiling district only. In the present paper 15 and 24 species of Hemiptera have been encountered from wetlands of Darjiling and Jalpaiguri districts respectively. Biswas *et al.*, (1995a, b, c) recorded 50 and 1 species of aquatic coleopterans from Darjiling and Jalpaiguri districts respectively. In the present paper only 4 and 8 species of Coleoptera have been reported from wetlands of Darjiling and Jalpaiguri districts respectively. Srivastava and Sinha (1993) found 90 and 43 species of Odonata from Darjiling and Jalpaiguri districts respectively. Srivastava (1993) observed 7 and 13 species of Ephemeroptera from Darjiling and Jalpaiguri districts respectively. Chaudhuri and Chattopadhyay (1997) recorded a number of chironomid species from this region.

**Arachnids** : Four species of spiders belonging to three genera and two undetermined species of water mites could be collected from wetlands of Darjiling and Jalpaiguri districts. Biswas and Biswas (1992) in their document on spider fauna of West Bengal reported the occurrence of the genus *Lycosa viz., L. carmichaeli* Gravely, *L. himalayensis* Gravely and *L. kempi* Gravely from Darjiling district, the genus *Pardosa (P. annandalei)* (Gravely), *P. birmanica* Simon, *P. shyamae* (Tikader), *P. sumatrana* (Thorell) and *P. sutherlandi* (Gravely) from Darjiling and Jalpaiguri districts and the genus *Tetragnatha (T. andamanensis* Tikader and *T. mandibulata* Walckenear) from these two districts. However, Dasgupta (1995) recorded six species of spiders viz., *Leucauge* sp., *Liarimia* sp., *Cyclosa* sp., *Theridion* sp. *Tetragnatha* sp. and *Xyaticus (=Xysticus)* sp. from lentic habitats in Darjiling district.

**Annelids** : Three species of annelids comprising of one species of freshwater oligochaete, *Limnodrilus* sp. and two species of leeches viz., a land leech, *Haemadipsa* sp. and an aquatic leech, *Glossiphonia* sp. have been recorded from wetlands of these two districts.

**Molluscs** : Thirteen species of gastropod and bivalve molluscs belonging to 8 families have been found to occur in freshwater wetlands of Jalpaiguri district but not a single species could be recorded from Darjiling district. However, a few species of freshwater molluscs viz., *Bellamya bengalensis, Thiara tuberculata, Thiara lineata, Paludommus* spp., *Lamellidens corrianus* and *Parreysia lima* have been recorded in Darjiling district out of 75 species reported from West Bengal by Thakur *et al.* (1992). Among the wetlands, Narathaly Lake of Buxa Tiger Reserve is dominated by a wide variety of gastropod and bivalve species in abundance.

**Zooplankton** : In all, 45 species of zooplankton belonging to Copepoda, Ostracoda, Cladocera, Conchostraca and Rotifera have been recorded from freshwater wetlands of Darjiling and Jalpaiguri

districts (Table 7). Of these, 38 species (84.4%) are represented by cladocerans, three species by ostracods and two species each of copepods and rotifers, while one species viz., *Cyclestheria hislopi* Baird belongs to Conchostraca. Of the two districts, 12 species of zooplankton are recorded from Darjiling and 40 species from Jalpaiguri districts. Among ostracods, *Astenocypris papyracea* (Sars) constitutes new report from West Bengal (Venkataraman, 2000). Out of 38 species of cladocerans three species viz., *Alona guttata* Sars, *Daphnia pullex* Leydig and *Streblocerus serricaudatus* (Fischer) recorded herein for the first time from West Bengal.

Of the five different groups of zooplankton, cladocerans represent highest diversity of species particularly inhabiting littoral vegetation. Among copepods, *Mesocyclops* occur in the limnetic region of almost all the wetlands surveyed. The ostracod and conchostracan species are recorded from Jalpaiguri district only. In over all, zooplankton diversity is poor in this region of North Bengal (Dasgupta, 1995) than that of South Bengal (Nandi *et al.*, 1999; 2001a, b). However, it may be mentioned that Dasgupta (1995) reported seven species of crustacean zooplankton such as *Cyprinotus gunningi, Illycypris* sp., *Daphnia carinata, Chydorus* sp., *Daphniopsis* sp., *Diaphanosoma tibetnus* and *Cyclops* sp. from Darjiling Himalayas and recorded the smaller zooplankton taxa (Family : Cyclopidae and Chydoridae) in high abundance in lentic habitats at lower altitudes during the periods of most heavy rainfall in June-July months.

## DISCUSSION

The faunal diversity in the selected freshwater wetlands of Darjiling and Jalpaiguri districts represents a total of 220 species of 13 major groups (Table 8). The freshwater wetlands of North and South 24-Parganas districts representing the coastal plains were inhabited by 235 species, while those of Haora and Hugli districts under the Gangetic plains represented 286 species (Nandi *et al.*, 1993; Nandi *et al.*, 1999). Among the two districts, wetlands of Darjiling hills are inhabited by 94 species only but wetlands of terai-duars region represent 207 species, *i.e.*, more than double the species occurring in the hill region. This may be due to poor representation wetlands and also due climatic condition in the hills.

In general, Darjiling hills and the duars regions are faunistically well explored and rich in terrestrial fauna including a large number of mountain inhabiting species and hill stream fishes (Agarwal *et al.*, 1992; Ahmed and Dasgupta, 1992; Sarkar *et al.*, 1992; Sen, 1992). Dasgupta (1995) studied the trophic structure of some lentic habitats of Darjiling Himalayas and reported 7 species of plankton (Crustaceans), 11 species of nekton (fish and amphibians), 29 species of periphyton (insects and spiders), 5 species of neuston (insects) and 5 species of benthos (single species each of Pisces, Gymnophiona, Crustacea, Diptera and Bivalvia).

There are a number of wildlife sanctuaries in these two districts of northern West Bengal (Saha *et al.*, 1992). These sanctuaries as well as flood plain regions of this part of West Bengal have diverse type of wetlands and wildlife. The hill streams in this region have a tendency to cut new channels including 'cross-country' watercourses forming numerous pools and marshes, which are favourite hunts of rhino. The cutting of reeds and killing of wildlife in wetlands and woodlands are reported from this region. It is, therefore, felt that the wetlands as well as threatened species of wildlife inhabiting wetlands viz., rhino, wild buffalo, salamander etc. protected and included under the Schedules of the Indian Wildlife (Protection) Act (1972) should be thoroughly surveyed and meticulously conserved. Some of these species viz., Hispid Hare, *Caprolagus hispidus* (Pearson), Pygmy Hog, *Sus salvanius* (Hodgson), Great One horned Rhino, *Rhinoceros unicornis* (Linnaeus) and Wild Buffalo, *Bubalus bubalis* (Linnaeus) have now confined to this part of West Bengal. So, the status of these large animals and the rules and regulations prohibiting their exploitation in wetlands and wildlife sanctuaries in this region need to be strictly enforced.

## SUMMARY

1. A faunal inventory of 15 freshwater wetlands, 6 from Darjiling district and 9 from Jalpaiguri district dealing with 93 species of vertebrates and 122 species of macroinvertebrates and zooplankton is communicated.
2. The vertebrate elements include 6, 20, 6, 7 and 54 species of mammals, birds, reptiles, amphibians and fishes respectively and invertebrate organisms include 82 species of macroinvertebrates and 45 species of zooplankton.
3. Three species of Cladocera constitute new records from West Bengal.
4. The diversity of fauna is discussed with reference to Gangetic plains and Coastal plains of West Bengal.

## REFERENCES

Agrawal, V C., Das, P. K., Chakraborty, S., Ghose, R. K., Mandal, A. K., Chakraborty, T. K., Poddar, A. K., Lal, J. P., Bhattacharyya, T. P. and Ghosh, M. K. 1992. Mammalia. *State Fauna Series : Fauna of West Bengal,* **3**(1) : 27-169.

Ahmed, S. and Dasgupta, G. 1992. Reptilia. *State Fauna Series : Fauna of West Bengal*, **3**(2) : 1-65.

Anonymous. 1995. Faunal wealth of Buxa Tiger Reserve. *News Letter*, Buxa Tiger Reserve, **2**(1) : 4.

Bal, A. and Basu, R. C. 1994a. Insecta : Hemiptera : Mesoveliidae, Hydrometridae, Veliidae & Gerridae. *State Fauna Series : Fauna of West Bengal*, **3**(5) : 511-534.

Bal, A. and Basu, R. C. 1994b. Insecta : Hemiptera : Beelostomatidae, Nepidae, Notonectidae and Pleidae. *State Fauna Series : Fauna of West Bengal*, **3**(5) : 535-558.

Banerji, A. K., De, B., Majumdar, D., Mukherji, S. P., Ray, P., Sengupta, K. S. Bhattacharya, B. K., Kusari, A. M., Nag, R. N., Sen, N. N. and Sengupta, S. 1980. *West Bengal District Gazeteers : Darjeeling*. Calcutta, Government of West Bengal (State Editor).

Biswas, B. and Biswas, K. 1992. Araneae : Spiders. *State Fauna Series : Fauna of West Bengal*, **3**(3) : 357-500.

Biswas, S., Mukhopadhyay, P. and Saha, S. K. 1995a. Insecta : Coleoptera : Adephaga : Fam. Dytiscidae. *State Fauna Series : Fauna of West Bengal*, **3**(6A) : 77-120.

Biswas, S. Mukhopadhyay, P. and Saha, S. K. 1995b. Insecta : Coleoptera : Adephaga : Family Gyrinidae and Family Haliplidae. *State Fauna Series : Fauna of West Bengal*, **3**(6A) : 121-141.

Biswas, S. and Mukhopadhyay, P. 1995c. Insecta : Coleoptera : Hydrophilidae. *State Fauna Series : Fauna of West Bengal*, **3**(6A) : 143-168.

Chanda, S. K. 1986. On a collection of Anuran amphibians from Darjeeling and Sikkim Himalayas, with description of a new species of *Rana* (Ranidae). *J. Bengal nat. Hist. Soc. (N. S.)*, **5**(2) : 140-151.

Chaudhuri, P. K. and Chattopadhyay, S. 1997. Insecta : Diptera : Chironomidae. *State Fauna Series : Fauna of West Bengal*, **3**(7) : 163-224.

Dasgupta, R. 1995. The trophic structure and physical characteristics of some lentic habitats in Darjeeling Himalayas. *J. Bengal nat. Hist. Soc. (N. S.)*, **14**(1) : 11-40.

De, M., Bhuinya, S. and Sengupta, T. 1989. A preliminary account of major wetland fauna of Calcutta and its surroundings. *Encology*, **3**(4) : 5-11.

Ghose, R. K. and Ghosal, D. K. 1985. Recent occurrence of Hipsid Hare, *Carpolagus hispidus* (Pearson) in duars of West Bengal. *Bull. zool. Surv. India*, **6** : 315-316.

Ghosh, A. K. 1990. Biological resources of wetlands of East Calcutta. *Indian J. Landscape System and Ecol. Studies*, **13**(1) : 10-23.

Hora, S. L. and Gupta, J. C. 1941. On a collection of fish Kalimpong Duars and Siliguri Terai, Northern Bengal. *J. Asiat. Soc. Bengal (Science)*, Calcutta, **47** : 183-202.

Inglis, C. M. 1940. The Painted Snipe *Rostratula benghalensis* (Linn.). The Woodcock (*Scolopax r. rusticola*) in the Duars. *J. Bengal nat. Hist. Soc.*, **15** : 1-17.

Jayaram, K. C. and Singh, K. 1977. On a collection of fish from North Bengal. *Rec. zool. Surv. India*, **72**(1-4) : 243-276.

Kusari, A. M., Sengupta, R. S., Bhattacharya, B. K., Ray, P. R., Chakraborti, B. R., Mukherji, S., De, B. and Sengupta, S. R. 1981. *West Bengal District Gazeteers : Jalpaiguri.* Calcutta. Government of West Bengal (State Editor).

Lister, M. D. 1954.A contribution to the Ornithology of the Darjeeling area. *J. Bombay nat. Hist. Soc.*, **51** : 742-743.

Nandi, N. C., Das, S. R., Bhuinya, S. and Dasgupta, J. M. 1993. Wetland Faunal Resources of West Bengal. 1. North and South 24-Parganas Districts. *Rec. zool. Surv. India, Occ. Paper* No. **150** : 1-50.

Nandi, N. C., Venkataraman, K., Das, S. R. and Bhuinya, S. 2001a. Faunal diversicy of wetlands in the Botanical Garden, Haora, West Bengal. *Rec. zool. Surv. India*, **99**(1-4) : 111-129.

Nandi, N. C., Venkataraman, K., Das, S. R. Bhuinya, S. and Das, S. K. 2001b. Wetland Faunal Resources of West Bengal. 3. Birbhum District. *Rec. zool. Surv. India*, **99**(1-4) : 135-156.

Nandi, N. C., Venkataraman, K., Das, S. R., Bhuinya, S. and Das, S. K. 1999. Wetland Faunal Resources of West Bengal. 2. Some selected wetlands of Haora and Hugli Districts. *Rec. zool. Surv. India*, **97**(4) : 103-143.

Raychaudhuri, S. P., Agarwal, R. R., Datta Biswas, N. R., Gupta, S. P. and Thomas, P. K. 1963. *Soils of India.* Indian Council of Agricultural Research, New Delhi, 496 pp.

Saha, S. S. Chattopadhyay, S., Mukherjee, R. P. and Alfred, J. R. B. 1992. Wildlife and its conservation in West Bengal. *State Fauna Series 3 : Fauna of West Bengal*, Part 1 : 419-443.

Sanyal, P. 1994. Rare crane of India. *J. Bombay nat. Hist. Soc.*, **91**(1) : 453.

Sarkar, A. K., Biswas, M. L. and Ray, S. 1992. Amphibia. *State Fauna Series : Fauna of West Bengal*, **3**(2) : 67-100.

Sen, T. K. 1992. Freshwater Fish. *State Fauna Series : Fauna of West Bengal*, **3**(2) : 101-242.

Shaw, G. E. and Shebeare, E. O. 1937. The fishes of Northern Bengal. *J. Royal Asiat. Soc. Bengal (Science)*, **3**(1) : 1-137.

Spillet, J. J. The Jaldapara Wildlife Sanctuary, West Bengal. *J. Bombay nat. Hist. Soc.*, **63** : 534-556.

Srivastava, V. D. 1993. Insecta : Ephemeroptera. *State Fauna Series : Fauna of West Bengal*, **3**(4) : 19-49.

Srivastava, V. D. and Sinha, C. 1993. Insecta : Odonata. *State Fauna Series : Fauna of West Bengal*, **3**(4) : 51-68.

Thakur, D. K., Mitra, S. C. and Maitra, S. 1992. Land and Freshwater Molluscs, Part II. *State Fauna Series : Fauna of West Bengal*, **3**(9) : 53-127.

Venkataraman, K. 2000. New record of *Astenocypris papyracea* (Sars 1903), (Crustacea, Ostracoda) from West Bengal, India. *J. Bombay nat. Hist. Soc.*, **97**(2) : 304-309.

Woughton, R. C. 1916. Bombay Natural History Society's Mammal Survey of India. Report No. 26. Darjeeling District. *J. Bombay nat. Hist. Soc.*, **24** : 773-782.