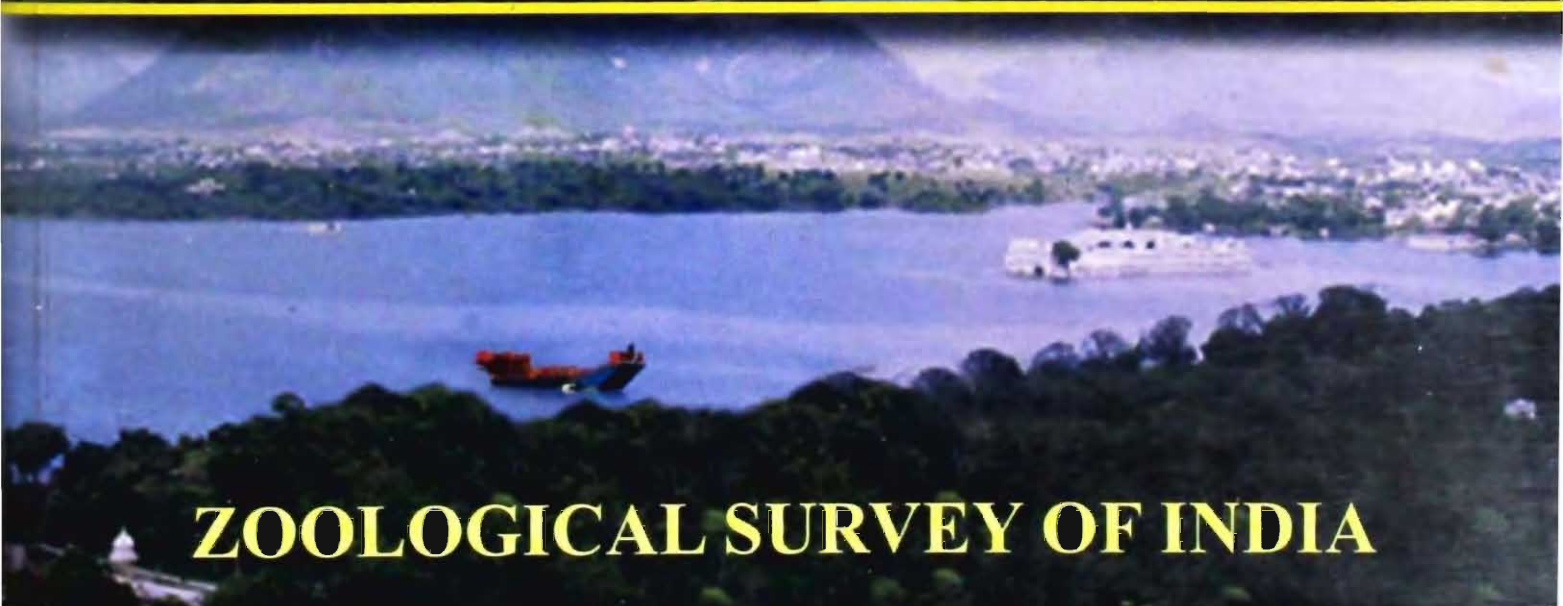


**Fauna of  
Pichhola Lake  
(Rajasthan)**



**ZOOLOGICAL SURVEY OF INDIA**

*Wetland Ecosystem Series 8*

# **Fauna of Pichhola Lake Rajasthan**

*Edited by the Director, Zoological Survey of India, Kolkata*



**Zoological Survey of India  
Kolkata**

## CITATION

Editor–Director. 2007. *Fauna of Pichhqla Lake, Wetland Ecosystem Series, 8* : 1-238.  
(Published by the Director, *Zool. Surv. India, Kolkata*)

Published : February, 2007

**ISBN 978-81-8171-142-7**

*Project Coordinators*

**S. Kumar and N.S. Rathore**

*Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan*

© Govt. of India, 2007

### **ALL RIGHTS RESERVED**

- No part of this publication may be reproduced stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- This book is sold subject to the condition that it shall not, by way of trade, be lent, resold hired out or otherwise disposed of without the publisher's consent, in an form of binding or cover other than that in which, it is published.
- The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

### **PRICE**

**Indian Rs. 700.00**

**Foreign : \$ 45; £ 30**

Published at the Publication Division by the Director Zoological Survey of India, 234/4, AJC Bose Road, 2nd MSO Building, 13th floor, Nizam Palace, Kolkata 700020 and printed at Power Printers, New Delhi- 110 002.

## CONTENTS

1. PICHHOLA LAKE : AN OVERVIEW ..... 1-33  
**N. S. Rathore and S. Kumar**
2. LIMNOLOGY ..... 35-53  
**S. Kumar and N. S. Rathore**
3. ZOOPLANKTON ..... 55-66  
**S. Kumar and N. S. Rathore**
4. CRUSTACEA : DECAPODA ..... 67-69  
**S. K. Ghosh**
5. CHILOPODA : SCOLOPENDROMORPHA ..... 71-73  
**Vinod Khanna**
6. INSECTA :
  - Thysanura ..... 75-78  
**A. K. Hazra and M. Biswas**
  - Odonata ..... 79-83  
**M. Prasad**
  - Orthoptera ..... 85-92  
**M. S. Shishodia**
  - Dermaptera ..... 93-95  
**G. K. Srivastava**
  - Dictyoptera : Blattaria ..... 97-99  
**S. K. Mandal and M. S. Shishodia**

Isoptera .....	101-107
<b>N. S. Rathore and N. Tak</b>	
Diptera : Chironomidae .....	109-112
<b>S. Kumar</b>	
Coleoptera .....	113-126
<b>P. Mukhopadhyay, S.K. Chakraborty, D.N. Biswas, S.K. Halder, S.K. Ghosh, P. Chakraborty and S. Sengupta</b>	
Hymenoptera : Formicidae .....	127-130
<b>N. Tak, N. S. Rathore and S. Kumar</b>	
7. MOLLUSCA .....	131-138
<b>S. C. Mitra, A. Dey and S. Barua</b>	
8. PISCES .....	139-166
<b>S. Kumar and N. S. Rathore</b>	
9. AMPHIBIA .....	167-170
<b>N. S. Rathore and S. Kumar</b>	
10. REPTILIA .....	171-179
<b>S. Kumar and N. S. Rathore</b>	
11. AVES .....	181-207
<b>S. Kumar and N. S. Rathore</b>	
12. MAMMALIA .....	209-216
<b>S. Kumar and N. S. Rathore</b>	
13. THREATS AND STRATEGIES FOR CONSERVATION .....	217-238
<b>S. Kumar and N. S. Rathore</b>	

# Chapter 1

## Pichhola Lake : An Overview



N.S. Rathore and S. Kumar



A View of Pichhola Lake

photo : S. Kumar



## **PICHHOLA LAKE : AN OVERVIEW**

**N.S. RATHORE AND S. KUMAR**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

Water is essential for perpetuation of life on earth and so is the case with wetlands. World's greatest civilizations have perpetuated on the banks of wetlands only. Wetland and wetland biota have been held in reverence as abodes of God. These jewels of water are considered as centres of absorbance and serenity. These landscapes of water with its flowering lotus, flocks of swans, turtles and fish have inspired many in the world to the extent that once Sage Valmiki, in the first-ever Sanskrit verse narrated the story of a courting pair of Sarus dying from a hunter's arrow on the shores of a lake. Wetlands have also been considered as dwellings of ghosts, reservoir of diseases and obstacles to development. Therefore they were drained, filled and reclaimed. But in fact, wetlands are the kidney of nature without which the body of this earth cannot function.

In India, wetlands are found in every geographical regions. From cold arid zones of Ladhak, warm arid zones of Rajasthan, tropical monsoonic central India, wet northeastern region, wet southern Peninsula to the coastal wetlands of India; they are as diverse and large as the ethnic population of India. The area under natural wetlands is 1.45 million ha. and under man-made wetlands, it is around 2.58 million ha. According to some estimate only 28 percent of the area of 93 important wetlands in India is under total protection, which amounts to 53 sites out of the 93 sites. This number does not include vast number of small, scattered aquatic habitats throughout the country (Anonymous, 1993 a & b).

Out of the 85 wetland sites of National Importance in the country, 95 per cent are subjected to moderate or high threats. The problems faced by Indian wetlands relate to weed infestation, siltation, pressures of agriculture and encroachments of wetlands, chemical and organic pollution and eutrophication besides conversion of wetlands for industrialization, urbanization and habitation (Anonymous, 1993 a & b).

Ecologically, wetlands may be viewed as more important ecosystem, transitional between open water and terrestrial ecosystem, endowed with specific structural and functional attributes and performing major ecological role in the biosphere. They differ widely in their biotic and abiotic structure.

Wetlands are areas of marsh, fen, peat land or water whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish including marine waters not beyond six metres deep. Wetlands maintain balance of nature. They control flood, store and purify water, protect shores and hinterlands, floral and faunal habitats, gene pools and recreational sites besides providing commercial outputs to sustain

rural communities. The world Wetland Day is celebrated on 2<sup>nd</sup> February to commemorate the signing of the Ramsar Convention on Wetlands which came into being on 1971. (Scott, 1989, Anonymous, 1993 a).

Human activities such as earth removal for storage of water, irrigation, etc. have resulted in creation of man-made wetland habitat in several regions throughout the country. In most parts of the world the natural wetlands are under increasingly greater human impact (draining, filling, dredging, hunting etc.) for a variety of socio-economic, aesthetic and other reasons. Wetlands are getting drained or degraded at an alarming rate in Asia. The 4<sup>th</sup> meeting of the Conference of the Contracting parties of Ramsar convention, which took place in Montreux, Switzerland in 1991, assessed the situation emerging from the national reports as “In general the statements on the general situation reflect an increase in awareness of value of wetland but considerable concern at continuing loss”

India by its unique geographical position and varied terrestrial and climate range has immense wealth of wetlands. India has three major perennial and mainly rain-fed river systems, the Indus, the Ganges and the Brahmaputra in the north. Whereas in central India the Narmada and the Tapi are present. Most of the natural wetlands of India are connected with the river systems of the north and the south. The various multipurpose projects launched to harness these river systems have also provided a number of man made wetlands eg. Harike at the confluence of the Beas and the Sutlej in Punjab, Bhakra Nagal in Punjab and Himachal Pradesh and the Kosi in Bihar-Nepal border. India also, has a network of lakes natural as well as man made like the Kabar Lake, the Chilika Lake, the Pichhola Complex and the Sukhna Lake etc. It is estimated that in all, India has about 4.1 million hectares of wetlands of which 2.6 million are man made.

Till the decade ago wetlands in India had been totally neglected. They were cleared for agriculture or drained for urban housing and industrial development. The Government of India has made concerted efforts for wetland conservation by setting up an expert group for compiling information on the ecological status of the wetlands in the country. The initiation was made in the seventh plan for wetland conservation. The first step of the effort was to bring out a directory of the wetlands of India (Anonymous, 1993 b). The second step of the effort was to evolve area specific management strategies for selected wetlands. A national wetland committee was set up in 1987 consisting of experts on different disciplines for advising the Government on the selection of sites and drawing up conservation strategies. The terms of reference of the committee were:

- (i) To frame broad policy guidelines for implementing the programmes on conservation, management and research on wetlands;
- (ii) To set up priority of wetlands for intensive conservation measures;
- (iii) To monitor the implementation of programme for conservation management and research;
- (iv) To advise on the preparation of inventory on Indian wetlands.

This committee in the first stage selected ten wetlands for preparation of management action plan and in the second stage added six more wetlands. The 16 wetlands thus selected for evolving management strategies were :

- |                              |                               |
|------------------------------|-------------------------------|
| 1. Kolleru (Andhra Pradesh)  | 9. Sasthamkotta (Kerala)      |
| 2. Wular (Jammu and Kashmir) | 10. Harike (Punjab)           |
| 3. Chilika (Orissa)          | 11. Kanjli (Punjab)           |
| 4. Loktak (Manipur)          | 12. Ujani (Maharashtra)       |
| 5. Bhoj (Madhya Pradesh)     | 13. Sukhna (Chandigarh)       |
| 6. Sambhar (Rajasthan)       | 14. Renuka (Himachal Pradesh) |
| 7. Pichhola (Rajasthan)      | 15. Kabar (Bihar)             |
| 8. Ashtamudi (Kerala)        | 16. Nalsarovar (Gujarat)      |

Out of these sixteen selected wetlands eleven have attained the status of wetland of international importance as Ramsar sites. Pichhola Lake was later brought under National Lake Conservation Plan (NLCP) as part of the Udaipur Lake Complex from Rajasthan. At present 71 wetlands have been identified under national wetland conservation programme of India as given below :

State/UT	No. of wetlands	Name of Wetlands
Andhra Pradesh	1	Kolleru
Assam	1	Deepar Beel
Bihar	1	Kabar
	2	Barilla
	3	Kusheshwar Asthan
Gujarat	1	Nalsarovar
	2	Great Rann of Kachh
	3	Thol Bird Sanctuary
	4	Khijadiya Bird Sanctuary
	5	Little Rann of Kachh
	6	Pariej
	7	Wadhvana
	8	Nanikakrad
Haryana	1	Sultanpur
	2	Bhindawas
Himachal Pradesh	1	Renuka
	2	Pong Dam

State/UT	No. of wetlands	Name of Wetlands
	3	Chandratal
	4	Rewalsar
Jammu & Kashmir	1	Wullar
	2	Tso Morari
	3	Tisgul Tso
	4	Hokersar
	5	Mansar-Surinsar
	6	Ranjitsagar
Jammu & Kashmir (Ladakh)	1	Pangong Tsar
Jharkhand	1	Udhwa
Karnataka	1	Magadhi
	2	Gudavi Bird Sanctuary
	3	Bonal
	4	Hidkal & Ghataprabha
Kerala	1	Ashtamudi
	2	Sasthamkotta
	3	Kottuli
	4	Kadulandi
	5	Vembnad Kol
Madhya Pradesh	1	Barna
	2	Yashwant Sagar
	3	Wetland of Ken River
	4	National Chambal Sanct.
	5	Ghatigaon
	6	Ratapani
	7	Denwa Tawa wetland
	8	Kanha Tiger Reserve
	9	Pench Tiger Reserve
	10	Sakhyasagar
	11	Dihaila
	12	Govindsagar

State/UT	No. of wetlands	Name of Wetlands
Maharashtra	1	Ujni
Manipur	1	Loktak
Mizoram	1	Palak
Orissa	2	Tamdil
	1	Chilka
Punjab	1	Harike
	2	Ropar
	3	Kanjli
Rajasthan	1	Sambhar
Tamil Nadu	1	Point Calimer
	2	Kaliveli
	3	Pallaikarni
Tripura	1	Rudrasagar
Uttar Pradesh	1	Nawabganj
	2	Sandi
	3	Lakh Bahoshi
	4	Samaspur
Uttaranchal	1	Ban Ganga Jhilmil Tal
West Bengal	1	East Calcutta
	2	Sunderbans
	3	Ahiron Beel
	4	Rasik Beel
	5	Santragachi

First step in this direction was made by designating one or more research institution for each of the area for action oriented research. Each of these nodal research institutions was also made to represent the steering committee at the state level. This made the programme more integrated at the macro *i.e.* national level and micro *i.e.* state level with an in depth area specific research back up. In this way various activities have been initiated for mapping up of the wetlands and detailed resource survey of each of these areas to have area specific action plan combining short and long-term perspectives.

In recent years, the Ministry of Environment and Forests has taken several important steps for the conservation of wetlands, mangrove and coral reefs habitat in the country.



The Botanical Survey of India and the Zoological Survey of India, Ministry of Environment and Forests have been entrusted the work to carry out studies on flora and fauna respectively of all selected wetlands (Tewari, 1994). Since, the Zoological Survey of India was assigned to assess the faunal resource of Pichhola Lake, a project entitled "Faunal Survey of Pichhola Lake, Udaipur District" was taken up by the Desert Regional Station of Zoological Survey of India, Jodhpur under the leadership of Dr. N.S. Rathore and Dr. Sanjeev Kumar. Many faunistic surveys were undertaken during 1994 – 1997 to collect and identify the faunal diversity of the lake Pichhola. The survey parties also collected data on various other parameters of importance to the wetland so as to project strategies for the conservation of various valuable taxa and the ecosystem.

### PICHHOLA LAKE

Brimmed with emerald green water bodies, Udaipur is called city of lakes. The saucer shaped basin known by the name of Udaipur city is one of the unique micro-geographical regions of the state of Rajasthan. Udaipur city is located at 578 AMSL between latitude  $24^{\circ} 35' N$  and longitude  $73^{\circ} 42' E$  and surrounded by Aravalli Range from all side and in the east by many lakes.

Though it is a part of ancient Ayad civilization of 10<sup>th</sup> B.C., the district is named after its principal city, Udaipur which Rana Udai Singh founded in about 1559-1560 AD and acquired its name after him. It remained the seat of government of the erstwhile state of Mewar, for centuries. The district is located between latitudes  $23^{\circ} 46'$  to  $26^{\circ} 2' N$  and longitudes  $73^{\circ}$  to  $74^{\circ} 35' E$ . It shares its borders with six other districts of Rajasthan viz Sirohi, Pali, Rajsamand, Chittaurgarh, Banswara, Dungarpur and Sabarkantha district of Gujarat (Fig. 1). The district possesses a number of artificial lakes and tanks, the most important being the Jaisamand, the Rajsamand (now in Rajsamand District), the Udaisagar, the Pichhola, the Fatehsagar, the Sarjana (Vallabhnagar), the Bagolia and the Dewas (Gorana-Ki-Nal). These lakes have a special place in the natural beauty of Udaipur. They have not only attracted tourists but are providing economic support to Udaipur and the main source of drinking water.

Pichhola Lake is like a mother wetland to the lake ecosystem of Udaipur region. It contributes to the riverine system of this region and the general ambience is maintained by the seven lake units in this region. Lake system of Udaipur is shown in Fig. 1a. The western part of Udaipur city is comparatively elevated and hence Pichhola, Swaroopsagar and Fatehsagar lakes were constructed. The main city is established at the eastern slope below the level of the lakes. The lakes Fatehsagar and Pichhola are interconnected. A part of Pichhola in confluence with Fatehsagar is alternatively known as Swaroopsagar. On one end, the lake Pichhola is connected with a small but relatively deeper tank called Dudh Talai. Pichhola and Swaroopsagar have a combined water spread of 381 ha. at F.T.L. while Fatehsagar has water spread of about 258 ha at F.T.L. Berach basin together with local nalah and Sisarma River – a tributary of Berach River form the source of water for lakes Pichhola and Fatehsagar.



Detailed map of Pichhola Lake

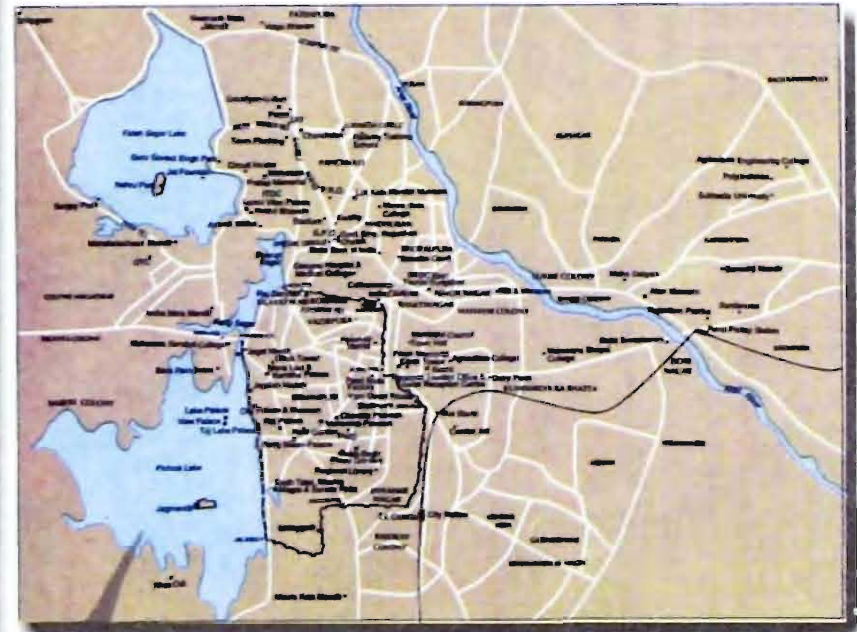


Fig. 2. Map showing location of Pichhola Lake in Udaipur district in Rajasthan, India.

Modified from Source : Rajasthan Road Atlas - 2001 (IMS) : Brochure on Birds & Fishes of Pichhola.

The wetlands types in Udaipur basin can be classified according to Saint, *et al.*, 1994 as the Lacustrine System (Littoral Zones of lakes often characterized by rooted emergent plants): Fateh Sagar (Northern, Western and Southern Shorelines); Pichhola Lake (Sisarma Nadi Delta); Kalalia Talab, Rangasagar, Swarupsagar System including Goverdhansagar (Northern, Western and Southern Littoral Zones) and Bari Ka Talav (Northern and Southern Littoral Zones). The Riverine System (In the active channels and along the banks, mostly along the Ahar River and tributary channels draining from the lakes) and the Palustrine System: Swamps and Bogs in spring and seeps, abandoned channels and other with shallow water table conditions.

Pichhola Lake is the oldest in Udaipur city, reported to be in existence since the thirteenth century. It is named after the village Pichholi then existing on its banks and is said to have been constructed by a Banjara (Grain carrier) at the end of the fourteenth century and the embankment was raised by Rana Udai Singhji in 1559-1560 A.D. But historically, Maharana Udai Singh established Pichhola Lake in the 14th century by stopping the flow of Kotda River. The beauty of the lake is because of a Jagmandir Mahal in its centre built in 1628-1652 by Maharana Jagat Singh and Jag-niwas (presently a world famous Five Star Hotel called Lake Palace) in its western part constructed by Maharana Jagat Singh II (1734-1751). In its southern part exists Haridas ji Ki Magri, a small hill protected by Maharana Fateh Singh with a masonry wall built around it for a wild setting of trees and pastures for animals. Besides these important landmarks it has other important points named after important avifauna of the lake (Fig. 2).

It is reported that heavy rains have breached the masonry embankments of the lake Pichhola and washed away most of the Udaipur town in 1795. The embankments were later repaired and strengthened during 1825-1838. The lake was afterwards connected with lakes Rangasagar and Swaroopsagar on the northern side. The lake Pichhola has a water spread of 10.8 sq. kms., with a maximum depth of 9.15 m., the average being 5.6 m. This is the only marginal area where recession of water in summer is experienced. The lake is a storage type reservoir and receives its water supply through run-off from the catchment area of Aravalli hills and through a seasonal river Sisarma, a tributary of Berach River, which meets the lake at its western side.

Among the several wetlands Lake Pichhola is an age-old water body, which experienced a total drought in the summer of 1973 due to drought for two consecutive years in 1971-1972. During this period the lake bottom got exposed and developed cracks. The aquatic organisms especially fishes were either removed by human activity or got killed due to unfavourable environmental conditions (Durve and Rajbanshi, 1975).

The eastern side of Pichhola Lake can be divided into three main areas (i) Navghat to Chand Pol area, (ii) Braham Pol, Amba Pol to Chand Pol area and (iii) Navghat to New Pulia (Hatipol) area.

Now with the increased development and no attention being paid to the existing sewerage system the pollution in the lake has taken a serious form. The main cause of pollution is



the direct flow of sewerage waste of the human settlement around the lake into these three main areas of the Pichhola Lake.

In the present publication, the result of the survey, together with information available from earlier works have been collected, compiled and presented in the forms of separate papers on different groups. Research projects and thesis on surface waters of Udaipur are being mentioned in the chapter of Limnology. Satellite imageries of Pichhola Lake have been worked out by Garg, *et al.* (1998). Brief information on relevant aspects as climate, geology and hydrology, soil and vegetation have been given to act as a general prologue to all the contributions included in the publication.

### CLIMATE

The area is characterized by tropical monsoon climate with an annual rainfall of about 490 mm – 640 mm., the maximum of it reaches upto 700 mm. (Fig. 3). The rainy season is from July to September. Temperature rises up to 45°C in summer and falls up to 8°C in winter. The temperature of the lake varies from 15°C in December January to 34°C in May-June. The air temperature is low during winter, moderate during monsoon and high in summer. The surface water temperature is generally higher in the months of June to September.

### GEOLOGY and HYDROLOGY

The region is part of intermittent range of the lower Vindhyan system and the Aravalli's. It also includes Bap beds of Upper Carboniferous, few Jurassic formations of Jurassic period, Deccan Trap of Cretaceous and formations of Eocene age. It is characterized by basic and ultra basic rocks, granites, basic intrusive Delhi-system, ultra basic intrusives and Erinpura Granite. It has also some alluvial and blown sand of the recent age.

Geology of the udaipur valley (both phosphates and non-phosphatic) are seen in different blocks of the Jhamarkotra deposit, as well as at Maton, Kanpur, Sisarma, Bargaon, Dakankotra, Kharbaria-Ka-Gurha, and Neemach Mata. At the northern abutment of the Fateh Sagar Dam, stromatolites can be seen at the place where canal from Madar joins the lake; the nearest locality where these algal structures can be seen in Udaipur. Both the basal volcanoclastic sediments and carbonates constitute the Lower Aravalli Group in the type area. After the deposition of carbonates associated with rock phosphate and uraniferous black shale, the area was once again subjected to tectonic rejuvenation. The two faults which shaped the Epicontinental Sea once again became active. The source area was uplifted supplying more and more sediments to the Epicontinental Sea. As a result a thick sequence of conglomerate- greywacke-shale got deposited rapidly.

Most of the Udaipur City area is occupied by this greywacke-phyllite sequence. The conglomerate with large angular to sub-rounded blocks and boulders of different composition and studded in phyllitic matrix can be seen at Bhupalpura, at several places in the city area and also in the Hiran Magri Sectors. Fascinating greywacke-phyllite rhythmites can be seen in a road cutting south of Paras Cinema and around the Pala Ganeshji temple near the Sajjan Niwas Garden. It would be interesting to note that the rapid influx of terrigenous sediments continued in the Epicontinental sea till it was completely filled in and land conditions were evolved in its place. The greywacke-phyllite laminates forming the top part the sequence are best exposed at Pala Ganeshji. This sequence indicates how the supply of sediment from the source area gradually diminished and ultimately stopped. This conglomerate-greywacke- phyllite sequence of the Middle Aravalli Group is a classic example of a complete sedimentation cycle from formation of a basin to its complete filling up with the sediments. As a result, the Epicontinental Sea withdrew from the Udaipur valley and an Aravallian river occupied its place depositing an argillite-silty-arenite sequence with the lenticular bodies of polymictic conglomerate followed by a thick sand sequence at the base. This unit exhibits a variety of sedimentary structures as testimony of its fluvial origin. Variation in lithology from sand, silt to shale has made display of these structures rather conspicuous.

The fluvial sequence occupies the heart of the Udaipur valley forming a small hill that extends from Machala Magara in the south to Pratap Smarak (Moti Magari) in the north through the city palace. At Pratap Smarak, it takes a sharp turn and extends up to Bada Hawala in the west of Fateh Sagar Lake through Nehru Park. Fascinating sedimentary structures can easily be seen while strolling along the serpentine road along the eastern side of the Fateh Sagar Lake. Similar structures attract the attention of tourists visiting Manikya Lal Verma and Deen Dayal Upadhyay gardens on either sides of Doodh Talai, an eastern extension of the Pichhola Lake. Though the Epicontinental Sea withdrew from the Udaipur valley but it continued further south around Zawar depositing carbonates with lead and zinc. Deposition of sand-shale sequence continued through out the Aravalli period along the western slope of the linear landmasses that separated the epicontinental sea of Udaipur valley from the main deep sea. The rocks of deep sea sequence forming drab hills with egg-basket topography crop out further west of an important watershed that separates regional drainage to the Bay of Bengal from the one that goes to the Arabian Sea. Aravalli rocks show a very low grade of metamorphism (green schist facies) except along their contact with underlying basement the Mewar Gneiss, where high grade metamorphism resulted in formation of garnet, sillimanite, andalusite, kyanite, and chloritoid. The Metamorphism in the younger argillite-silty-arenite fluvial sequence is of even low order and the rocks look almost unmetamorphosed. Younger intrusives occur in the form of mafic and ultramafic dykes. One such dole-rite dyke crops out east of Nai village as its contact has metamorphosed from a carbonate rock to sideritic marble-popularly known as "Panther Marble" This dole-rite dyke can be seen at road bifurcation of Nai village on

way to Jharol. All along the periphery of the Girwa valley pockets of fine-flaky-talcose white hydrous mica, commercially utilized as “pyrophyllite”, are being economically exploited. These deposits at the contact of the Aravalli rocks with the basement represent pockets of paleosols confirming its unconformable character.

The rocks of the Aravalli Supergroups (2500-1900 m.a.) exposed in the type locality around Udaipur city, Rajasthan, represent a complete sedimentary cycle starting from the formation of a depositional basin to its complete filling up with the sediments. During the closing of the depositional cycle land conditions were evolved in the area around Udaipur city on which an Aravallian river, one of the world’s oldest river flowed during the Proterozoic time (Paliwal, 1998).

Present topography of the Udaipur valley and the amphitheater located in its heart has not been carved by the long time denudation and weathering alone but mainly by polyphase deformation that affected the Aravalli Supergroup of rocks. Two major and several minor folding episodes and a number of shear zones, both Precambrian and post-Precambrian, shaped the bedrock geology Machala Magara, Sajjangarh, and Pratap Smarak are good examples of superposed folding. Mesoscopic folds of different types can be seen at a number of places within the city. Greywacke-phyllite sequence displays not only folds but also different planer structures and their refraction fanning and curving is also well documented in this sequence, Neotectonic activity that brought disruptive changes in the land to the west of the Aravalli Mountain also left its signatures in this so-called stable shield.

Reversal of drainage of Saraswati and Drishadwati river system caused migration of population from riverbanks to hilly terrain of the Aravalli, Archeological findings of Ahar/Banas civilization excavated at several places like Bedla, Bhuwana, Bichari, Dabok, Bhimal and Dhulkot (Ahar) have links with the ancient civilization (4000 BP) that flourished on the banks of Indus and Saraswati rivers. All the subsequent Neotectonic changes controlled the debilitation and rehabilitation in the Udaipur valley. Climatic changes causing long term draught and flood conditions are also reflected in three stages of the Ahar Civilization well preserved at Dhulkot near the new campus of the Mohan Lal Sukhadia University (Paliwal, 1988, 1998).

The River Banas is originating from the Khamnor hills of the Aravalli Range (a major tributary of perennial river Chambal) and collects the major run-off of Udaipur district by its tributary Berach. The river Sisarma drains into seasonal river Berach, which feeds the Lake Pichhola and its overflow, drains into Swaroopsagar. From Swaroopsagar water is diverted through a canal to Fatehsagar Lake (Fig. 1a). Pichhola Lake is estimated to come into existence in the year 1382. It was later connected with Amaraskund and Rangagar and extended upto Swaroopsagar in 1916.

## SOIL

The soil is black brown or grey and loamy. The area falls under hills and hillock for soil category as per U.S.D.A. classification for major soils. The soil-eroded turbidity of the lake is highest during monsoon and lessens from September reaching its minimum in February and March.

## VEGETATION

The plankton fauna at the margins is poor probably due to heavy growth of weeds. It is rich in *Oscillatoria*, *Anabaena*, *Microcystis*. Floating weeds are uncommon but submerged weeds like *Hydrilla verticillata*, *Vallisneria spiralis*, *Potamogeton crispus* and *Chara bradypus* are present. Gupta (1972) worked on the blue-green algal flora of Rajasthan. Vyas (1968, 1986) has dealt with the phytoplankton of Lakes in and around Udaipur including Pichhola. Vyas and Kumar (1968) attempted studies of phytoplankton in an Indrasagar tank. Bohra (1975) worked on planktons of Jodhpur city. Dashora (1977) has studied algae in relation to drinking water supply in some waters of Udaipur. Pichhola Lake was almost choked with *Eichhornia* in 1980. *E. crassipes* is still a major problem devouring surface expanse of the lake waters. Ecological studies of Udaipur waters have been worked out by Shekhawat (1983) and Paliwal (1984). Hydrobiological studies are by Shukla (1986).

The bottom of the lake has carpet vegetation consisting of *Hydrilla*, *Vallisneria*, *Potamogeton* and *Myriophyllum*. The dominant phytoplanktons were *Microcystis*, *Merasmopedia*, *Navicula*, *Pinnularia*, *Nitzschia* and *Scenedesmus*. The southern side of the lake has forested area with trees species like *Acacia leucopholea*, *Azadirachta indica*, *Balanites aegyptiaca*, *Butea monosperma*, *Anogeissus pendula*, *Zizyphus mauritana*, *Tamarindus indica*, *Ficus* species, *Dendrocalamus strictus* etc.

## FAUNA

So far as the knowledge on faunal diversity of fresh water wetlands of Rajasthan is concerned work has been mainly carried out on the composition of zooplankton population and diversity apart from being scatteredly touched upon on other groups of animals associated with wetlands. Some of the noteworthy contributions on various aspects related to faunal diversity of fresh water wetlands of Rajasthan are by : Anonymous (?), Hume (1878), Tiwari (1951, 1962 a & b, 1963, 1965, 1966, 1968 and 1996), Hora and Mathur (1952), Mathur (1952), Aggarwal (1957), Mathur and Sidhu (1957), Krishna and Menon (1958), Datta Gupta, *et al.* (1961), Dubey and Mehra (1962), Moona, (1963), Biswas (1964, 1965 a & b and 1971), Nayar (1965, 1968 and 1971), Khera (1966), Dhawan (1967), Mahajan (1969, 1971 and 1977), Ray and Mukherjee (1969), Roonwal (1969 and 1982), Abdulali and Savage (1970), Datta and Majumdar (1970), Mansukhani and Murthy

(1970), Vazirani (1970 and 1977), Deb (1973), Khosla (1973), Mathur and Yazdani (1970 and 1973), Durve and Rajbanshi (1975), Kushwaha, *et al.* (1975), Bose and Mitra (1976), Durve (1976), Rao (1976), Durve and Kakkar (1977 and 1979), Mathur (1977), Bohra (1978), Chaudhary (1978), Ali (1979 and 1982), Bhargava and Alam (1980), Saxena and Bhargava (1980 and 1981), Sharma (1980), Sharma (1980), De Block (1981), Jakher, *et al.* (1981), Johal and Dhillon (1981), Misra, *et al.* (1981), Prasad and Thakur (1981), Saxena and Baskaran (1981), Soota, *et al.* (1981 and 1983), Soota, *et al.* (1981 and 1982), Basu and Choudhary (1982), Bhargava (1982 and 1985), Johal (1982), Mahajan, *et al.* (1982), Mahajan, *et al.* (1982 a & b), Sharma and Johal (1982), Bohra, *et al.* (1983), Jackson (1983), Shekhawat (1983), Soota and Saxena (1983 and 1984 a & b), Saxena (1984, 1988, 1996 a & b and 1998), Gole (1984), Jakher (1984 and 1986), Sharma, *et al.*, (1984), Gupta and Kulshreshta (1985), Karpowicz (1985), Sankhla, *et al.* (1985), Sharma and Durve (1985 a & b), Thakur (1985), Tikader and Sharma (1985), Agoramoorthy and Mohnot (1986), Ali and Vijayan (1986), Choubisa and Sharma (1986), George (1986), Johal and Sharma (1986), Khatri (1986), Shukla and Vyas (1986), Shukla, *et al.* (1986), Rao (1986 a & b, 1991 and 1995), Nama (1987), Rathore and Bohra (1987), Tak and Sewak (1987), Gopalarao and Durve (1988 and 1989), Gopalarao, *et al.* (1988), Haque and Vijayan (1988), Rao, *et al.* (1988), Srivastava (1988), Venkataraman (1988, 1990 and 1992 a & b), Bhupathy (1989 and 1990), Rao and Durve (1989 and 1992), Saxena (1989), Tehsin (1989), Ajithkumar (1990, 1991 and 1993), Bhupathy and Vijayan (1990), Sharma (1991), Sharma and Kulshreshta (1991), Tyagi and Miller (1991), Selvray (1992), Sharma, *et al.* (1992), Ajithkumar and Asthana (1993), Ajithkumar and Mittal (1993), Ajithkumar and Sankar (1993), Bahura, *et al.* (1993 a & b), Johal, *et al.*, (1993), Kumar and Asthana (1993), Ramachandran and Vijayan (1994), Soni (1994), Ajithkumar *et al.* (1995), Katfu and Mohonot (1995), Mukherjee (1995), Saxena and Rathore (1995), Liaquat (1996), Rahamani (1996 and 1997 a & b), Roy (1996), Subba Rao (1996), Tak (1996), Vyas (1996), Yazdani (1996), Baber (1997), Rahamani and Soni (1997), Sharma (1997), Vyas (1997), Bhupathy, *et al.* (1998), Kumar and Ahmed (1998), Sharma (1998), Sharma (1998), Verma (1998 a & b), Kumar and Rathore (1999), Srivastava and Saxena (1999), Meena (2001), Sharma (2001) and Chisthty (2002).

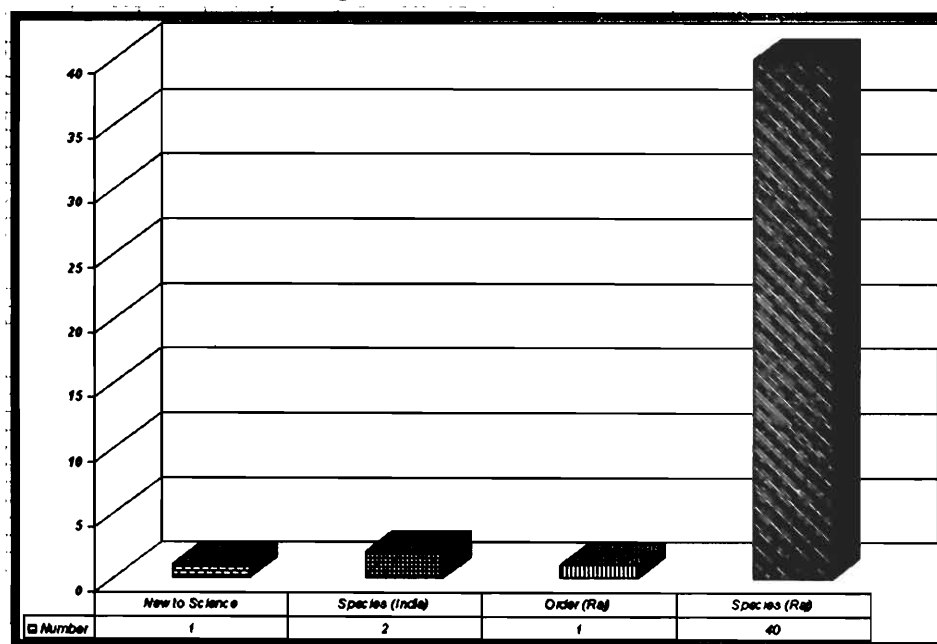
Although Pichhola Lake is an age-old wetland and remained right under the rulers of Princely state of Mewar for centuries, it is very surprising that no records of its fauna and flora have ever-been documented either by the rulers or by the British Raj. Some very relatively recent publication in the form of a brochure have been published by Lake Palace Hotels and Motels Pvt. Ltd., Udaipur on Birds and Fishes of Lake Palace (Pichhola), Udaipur prepared under the guidance of Shri R.S. Dharmakumarsinhji, M.B.O.U. and the than Vice-Chairman Indian Board of Wild Life (Annonymous ?).

**Table 1** : Faunal Diversity in different groups recorded from the Lake

Groups	Orders	Families	Genera	Species
Zooplankton	09	19	26	34
Crustacea	01	02	02	02
Chilopoda	1	2	4	4
Insecta	10	26	66	78
Mollusca	3	6	8	10
Pisces	5	12	15	26
Amphibia	1	2	3	3
Reptilia	3	7	9	9
Aves	22	22	51	71
Mammalia	6	9	10	10

### SUMMARY

In the present publication attempt has been made to workout the faunal diversity of Lake Pichhola along with its physico-chemical parameters, threats and suggestions for conservation strategies. From Protozoa to Mammalia, all the faunal groups available in and around Pichhola Lake were collected and have been identified as far as possible except where experts were not available. A total of 247 species of animals have been recorded from Pichhola Lake (Table 1). Among them 75 species are reported for the first time from Pichhola Lake. Out of these, 40 species and 1 order are recorded for the first time from Rajasthan, 2 species recorded for the first time from India and one species of Histeridae: Coleoptera found new to science (Fig. 4).

**Fig. 4.** New Records from Pichhola Lake (Invertebrates)

The vertebrate and invertebrate faunal diversity composition is also shown in Fig. 5 and 6 below :

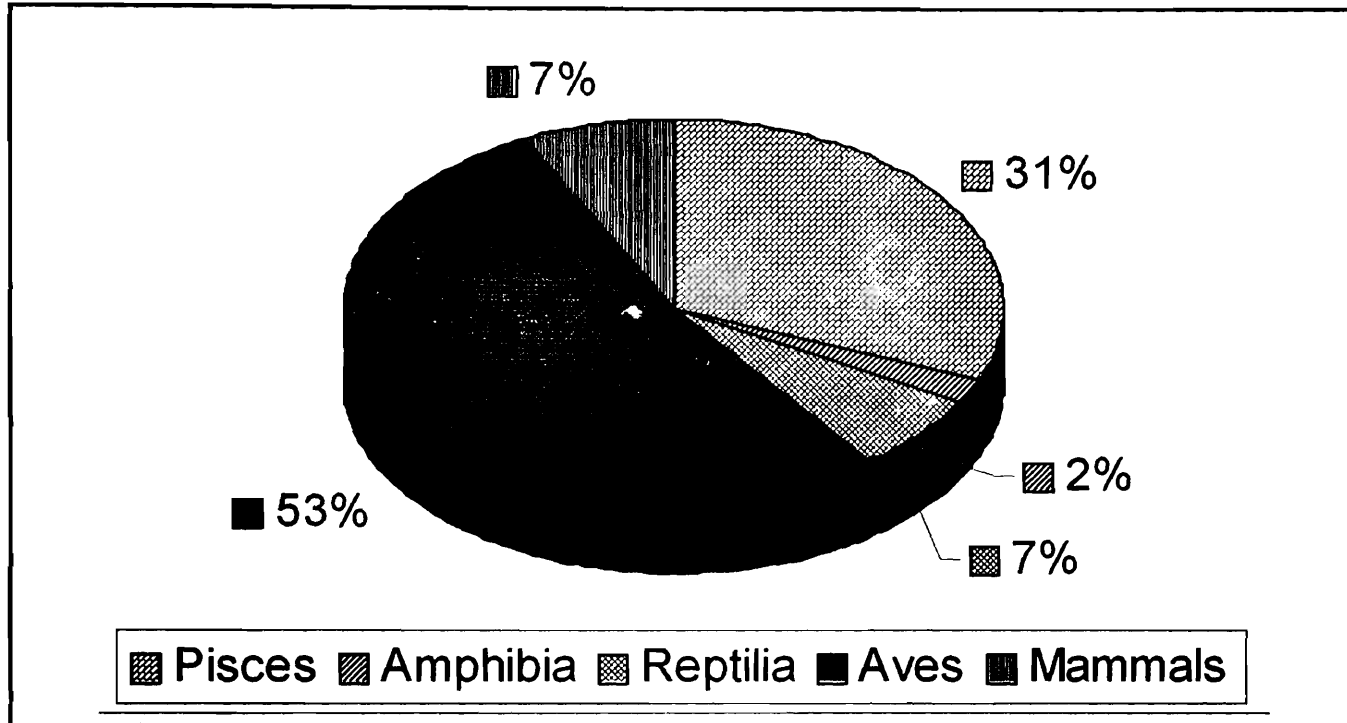


Fig. 5. Vertebrate Faunal Diversity of Pichhola Lake

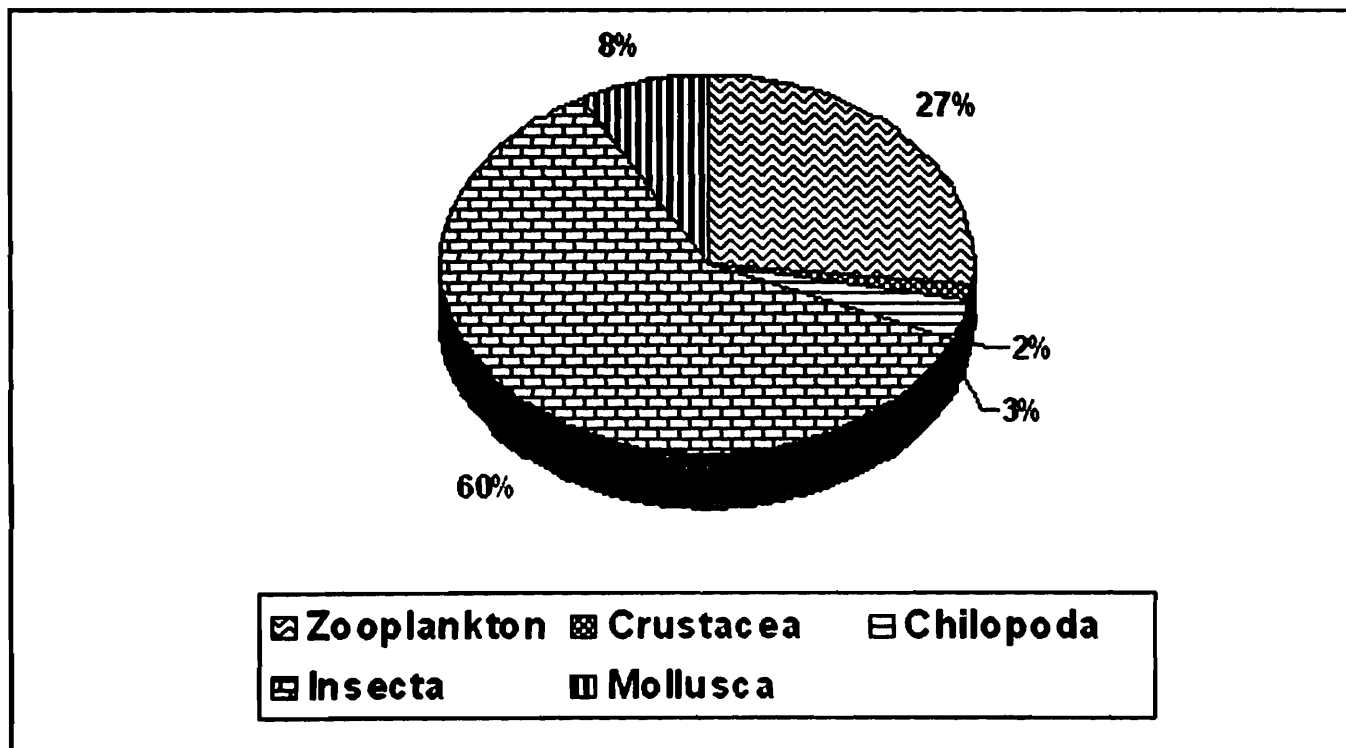


Fig. 6. Invertebrate Faunal Diversity of Pichhola Lake

### ACKNOWLEDGEMENTS

We are thankful to Dr. R.A. Khan, Director-In-Charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata for giving us the opportunity to work on this wetland of National Importance. We are deeply indebted to the Officer-in-charge, Desert Regional Station, Z.S.I., Jodhpur for providing facilities valuable suggestions and guidance all through the period of survey work. We acknowledge our sincere thanks to the Scientists of Zoological Survey of India, Kolkata and its Regional Station's who have identified the material and contributed papers in this publication. We are gratefully indebted to Late Dr. I. Prakash, Professor of Eminence, DRS, ZSI, Jodhpur, for his constant encouragement and lucid suggestions. We are thankful to the staff of DRS, ZSI, Jodhpur in helping us to conduct survey work efficiently. We are also thankful to the Estate of H.L.H. Maharana Shriji Arvind Singh Mewar, Udaipur, for allowing us to work in the lake Pichhola. We extend our thanks to various other organisations and individuals who helped us in various ways. We also thank to Smt. Seema Kumar, Scientist, AFRI, Jodhpur for helping us in updating information and lucid suggestions to make this piece of work more valuable. Thanks are due to Shri Mahendra Gandhi and Shri Rohit Bhati Jodhpur for assisting us in designing and type-setting of this publication. We finally express our thanks to Shri Rati Ram Verma, Publication Production Officer, Zoological Survey of India, Kolkata for his sincere efforts in bringing out this publication.

### REFERENCES

- Abdulali, H. and Savage, C.D.W. 1970. Status of the Main Wildfowl Resorts in India. In : *Proc. International Regional Meeting on Conservation of Wildfowl Resources*, (ed.) Y.A. Isakov, Leningrad, USSR, 25-30 September 1968, 335-337.
- Aggarwal, J.P. 1957. Contribution towards the Odonata fauna of Pilani. *Proc. 44<sup>th</sup> Indian Sci. Congr.*, Kolkata, part III, Abstract : 309.
- Agoramoorthy, G. and Mohnot, S. M. 1986. Migratory water birds around Jodhpur, India. *Tiger Paper*, 13(1) : 4-7.
- Ajithkumar, C.R. 1990. The fish community of Keoladeo National Park, Baratpur, Rajasthan. India. In : *Proc. of the IIInd Asian Fisheries Forum*, Tokyo, Japan, April 1989. (eds.) R. Hirana and I. Hanyu. The Asian Fisheries Society, Manila. Philippines : 385-388.
- Ajithkumar, C.R. 1991. Community and habitat segregation of the fish in Keoladeo National Park. Kanpur University, Ph.D. Thesis.
- Ajithkumar, C.R. 1993. *Aplocheilus panchax* (Ham.) - An addition to the fish fauna of Rajasthan. *J. Bombay nat. Hist. Soc.*, 90(1) : 115.
- Ajithkumar, C.R. and Asthana, A. 1993. The fish fauna of Rajasthan, India. *Rev. Life Sci.*, 13 : 133-148.

- Ajithkumar, C.R. and Mittal, D.D. 1993. Habitat preference of fishes in wetlands in relation to aquatic vegetation and water chemistry. *J. Bombay nat. Hist. Soc.*, **90**(2) : 181-192.
- Ajithkumar, C. R. and Sankar, K. 1993. Ichthyo-fauna of Sariska wild life Sanctuary. *J. Bombay nat. Hist. Soc.*, **90**(2) : 299-300.
- Ajithkumar, C.R., Ramachandran, N.K. and Asthana, A. 1995. Composition, abundance and distribution of fish in Banganga gambhir river system source of fish to the Keoladeo National Park, Bharatpur. *J. Bombay nat. Hist. Soc.*, **92**(1) : 30-39.
- Ali, S. 1979. Keoladeo Ghana water bird sanctuary. *Hornbill*, **13** : 27-29.
- Ali, S. 1982. Bharatpur: Wetland refuge for birds. *Sanctuary*, **2**(2) : 114-129.
- Ali, S. and Vijayan, V.S. 1986. *Keoladeo National Park Ecological Study*. Summary Report 1980-85. Bombay Natural History Society, Bombay, March, 1986.
- Anonymous, ?. Birds and Fishes of Lake Palace (Pichhola), Udaipur. Published by Lake Palace Hotels and Motels Pvt., Udaipur-India.
- Anonymous, 1993a. Directory of Indian Wetlands. WWF INDIA, New Delhi and AWB, Kuala Lumpur : xvi + 264pp., 32 maps.
- Anonymous, 1993b. *Environment Action Programme, India*. Ministry of Environment and Forests, Govt. of India. New Delhi.
- Anonymous, 2006. World Wetland Day 2006. In *Enviro News*, Newsletter on Environment & Forest Policies, Programmes and Activities. Environment Information System (ENVIS) Ministry of Environment and Forests Government of India, New Delhi. Vol. X, Jan-March.3-5.
- Bahura, C.K., Bahura, P. and Saxena, M.M. 1993a. Environmental monitoring of waters of the Indian desert: Zooplanktonic community of Shivbari temple tank, Bikaner. *J. Ecobiol.*, **5**(1) : 5-7.
- Bahura, R., Bahura, C.K. and Saxena, M.M. 1993b. A survey of zooplankton community of some waters of the Indian desert. In : *Curr. Trends linnol. Res.*, Vol. II. (ed.) N.K. Shastrees, Narendrra Pub. House, Delhi.
- Barber, Dinesh 1997. Studies on toxicity and bioaccumulation of cadmium in selected freshwater animals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Basu, D. and Choudhary, S. 1982. Status of the Gharial in Chambal river (Madhya Pradesh/Rajasthan). In: *Indian Crocodiles: Conservation and Research*. Proc. I. (eds.) L.A.K. Singh and B.C. Choudhury, Indian Crocodile Research Scholars Symposium, Forum of crocodile Researchers, India : 1-7.

- Bhargava, R.N. 1982. Records of the flamingo, *Phoenicopterus roseus* from Rajasthan Desert. *Camel's mouth Newsl. Indian Soc. Desert Tech.*, No. 82(2) : 5.
- Bhargava, R.N. 1985. Studies on aquatic Hemiptera of lentic habitats around Jodhpur. *Proc. Nat. Sympos. Evalu. Environ. (Spl. Vol. Geobios.)*. (eds.) S.D. Misra, D.N. Sen and I. Ahmad, : 318-320.
- Bhargava, S.C. and Alam, M. 1980. Macrobenthic fauna of Umaid Palace Pond. *Trans. Isdt. and Ucds.*, 5(2) : 48-50.
- Bhupathy, S. 1989. Status of the freshwater turtles in Keoladeo National Park Bharatpur. Sympos. On National Resources and their Conservation organized by the Division of Wildlife Biology, A.V.C. College. Mannampandal, Tamil Nadu, February 1989.
- Bhupathy, S. 1990. Observations on the food of the Ganges soft-shell turtle, *Trionyx gangeticus* in Keoladeo National Park, Bharatpur. *J. Bombay nat. Hist. Soc.*, 87(3) : 460-461.
- Bhupathy, S. and Vijayan, V.S. 1990. The fresh turtle fauna of eastern Rajasthan. *J. Bombay nat. Hist. Soc.*, 88(1) : 118-121.
- Bhupathy, S., Vijayan, V.S. and Mathur, R. 1998. Population ecology of migratory waterfowl in Keoladeo National Park, Bharatpur. *J. Bombay nat. Hist. Soc.*, 95(2) : 287-294.
- Biswas, S. 1964. A new species of the Cladoceran genus *Latona* Straus, 1820 (Crustacea : Cladocera : Sididae) from Rajasthan, India. *Proc. zool. Soc.*, 17 : 149-152.
- Biswas, S. 1965a. Fauna of Rajasthan, India, Part I. Crustacea: Cladocera, *Rec. zool. Surv. India*, 63(1-4) : 96-139.
- Biswas, S. 1965b. A new species of the genus *Chydorus* Leach, 1843 (Crustacea: Cladocera: Chydoridae) from Rajasthan, India. *Crustaceana*, Leiden, 11(2) : 113-114.
- Biswas, S. 1971. Fauna of Rajasthan India Part II Crustacea : Cladocera. *Rec. zool. Surv. India*, 63(1-2) : 95-141.
- Bohra, O.P. 1975. Freshwater planktons of Kailana and two reservoirs of Jodhpur, *Geobios*, 2(5) : 153.
- Bohra, O.P. 1978. Observations on diurnal rhythm of physico-chemical factors and Zooplankton at Chand Baori, Jodhpur. *Comp. Physiol. Ecol.*, 3(2) : 91-94.
- Bohra, P., Tak, N., Bhargava, R.N. and Rathore, N.S. 1983. Frogs of the Indian desert with illustrated key to their field identification. *Trans. Isdt. and Ucds.*, 8(2) : 113-118.
- Bose, B. and Mitra, T.R. 1976. The Odonata fauna of Rajasthan. *Rec. zool. Surv. India*, 71 : 1-11.

- Chaudhary, R.S. 1978. Fish and fisheries of Rana Pratap Sagar. *J. Inland Fish. Soc. India*, **10** : 76-84.
- Chishty, Nadim 2002. Studies on Biodiversity of freshwater Zooplankton in relation to toxicity of selected heavy metals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Choubisa, S. L. and Sharma, P. N. 1986. Incidence of larval trematodes infection and their seasonal variations in the freshwater molluscs of southern Rajasthan. *Rec. zool. Surv. India*, **83**(1&2) : 69-80.
- Dashora, M.S. 1977. Algae in water supply of Rajasthan. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Datta Gupta, A.K., Menon, P.K.B., Nair C.K.G. and Das, C.R. 1961. An annotated list of fishes of Rajasthan. *Proc. Rajasthan Acad. Sci. Pilani*, **8**(1 & 2) : 120-134.
- Datta, A.K. and Majumdar, N. 1970. Fauna of Rajasthan, India, Part 7 Fishes. *Rec. zool. Surv. India*, **62**(1 & 2) [1964] : 36-100.
- De Block, W. 1981. Some waterfowl counts in Gujarat and Rajasthan, India [1980]. Unpublished report.
- Deb, M. 1973. Fauna of Rajasthan (India). Crustacea: Ostracoda. *Rec. zool. Surv. India*, **67**[1969] : 233-259.
- Dhawan, S. 1967. Fish Fauna of Udaipur lakes. *J. Bombay nat. Hist. Soc.*, **66**(1) : 190-194.
- Dubey, G.P. and Mehra, R.K. 1962. Fish and Fisheries of Chambal River. *Proc. First All India cong. Zool. Jabalpur*, pt. II : 647-665.
- Durve, V.S. 1976. The fisheries of the lake Jaisamand, Rajasthan. *J. Inland Fish. Soc. India*, **8** : 19-23.
- Durve, V.S. and Kakkar, V.K. 1977. Fishery of selected impoundment around Udaipur. *Proc. All India Seminar on Ichthyology*, **44** : 23-24.
- Durve, V.S. and Kakkar, V.K. 1979. Fishery of Guda reservoir in Bundi district (Rajasthan). *Seafd. Export J.*, **11**(6) : 9-14.
- Durve, V.S. and Rajbanshi, V.K. 1975. Fish mortality and fishing during an unprecedented drought in lake Pichhola, Udaipur. *Indian J. Fish*, **22**(122) : 297-299.
- Garg, J.K., Singh, T.S. and Murthy, T.V.R. 1998. Wetlands of India, SAC (ISRO), Ahmedabad. Project Report : RSAM/SAC/RESA/PR/01/98. : 1-239.

- George, J. 1986. Cannibalistic behaviour of freshwater turtles in Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc.*, **83**(3) : 670-671.
- Gole, P. 1984. Some wetlands of ornithological importance in western India. Unpublished report submitted to the XXXth Annual Meeting of the International Waterfowl Research Bureau, Groningen, Netherlands, May 1984.
- Gopala Rao, N. and Durve, V.S. 1988. The probable antagonism in *Brachionus* (Rotatoria) species and Cyanobacteria in a Eutrophic lake of Udaipur, Rajasthan. *J. Environ. Biol.*, **9**(1) : 1-3.
- Gopalarao, N. and Durve, V.S. 1989. Cultural Eutrophication of the lake Rangasagar, Udaipur, Rajasthan, India. *J. Environ. Biol.*, **10**(2) : 127-134.
- Gopalarao, N., Durve, V.S and Sharma, L.L. 1988. Morphometric and Bathymetric features of four Udaipur lakes. (Rajasthan, India). *J. Hydrobiol.*, **IV**(1) : 29-31.
- Gupta, R.S. 1972. Blue green algal flora of Rajasthan. *Nova Hedwigia*, **63** : 481-492.
- Gupta, S.N. and Kulshreshta, S.D. 1985. Fish and fishery of the District Jhalawar, Rajasthan. *Intl. J. Acad. Ichthyol.*, **6** : 91-96.
- Haque, M.N. and Vijayan, V.S. 1988. Food habits of the smooth Indian otter (*Lutra perspicillata*) in Keoladeo National Park, Bharatpur, Rajasthan. First International Asian Otter Symposium, Bangalore. October 1988. *Abstract. Asian Otter Specialist Group Newsletter*, **1** : 17.
- Hora, S.L. and Mathur, B.B.L. 1952. On certain palaeographical features of Rajasthan as evidenced by distribution of fishes. *Bull. Nat. Inst. Sci. India*, **1** : 32-36.
- Hume, A.O. 1878. The birds of a drought. *Stray Feather*, **7** : 52-68.
- Jackson, P. 1983. Crisis for birds and buffaloes at Bharatpur. Unpublished Report.
- Jakher, G.R. 1984. Diurnal rhythm of zooplankton and certain abiotic factors in lake Balsamand (Jodhpur). *Oikoassay*, **1**(1 & 2) : 32-36.
- Jakher, G.R. 1986. Species diversity of macrobenthic fauna in a tropical lake. *Comp. Physiol. Ecol.*, **11** (4) : 217-225.
- Jakher, G.R., Dey, T., Misra, S.D. and Bhargava, S.C. 1981. Diurnal variations in Physico-Chemical factors and zooplankton population in Balsamand Lake, Jodhpur. *Geobios*, **8**(3) : 119-122.
- Johal, M.S. 1982. Field key to the fishes of Ganganagar district, Rajasthan. *Res. Bull. Punjab Univ.*, **33** : 43-49.

- Johal, M.S. and Dhillon, K.S. 1981. Ichthyofauna of Ganganagar district (Rajasthan), India. *Res. Bull. Punjab Univ.*, **32** : 105-107.
- Johal, M.S. and Sharma, K.P. 1986. Fish fauna of Swaimadhopur district, Rajasthan State, India. *Vest. cs. Spolec. Zool.*, **50** : 112-119.
- Johal, M.S., Chahal, I.S. and Tandon, K.K. 1993. Ichthyofauna of Rajasthan State. *J. Bombay nat. Hist. Soc.*, **90** : 404-411.
- Karpowicz, Z. 1985. Wetlands in East Asia: A preliminary review and inventory. ICBP Study Report No. 6. Cambridge : International Council for Bird Preservation.
- Katfu, D. and Mohonot, S.M. 1995. A checklist of the winter birds of the Kailana-Bijolai area. Jodhpur. *Newsl. for Birdwatchers*, **35** : 13-15.
- Khatri, T.C. 1986. Diurnal movement of zooplankton in Lakhota Lake. *Rec. zool. Surv. India*, **83**(1-2) : 135-143.
- Khera, S. 1966. Nematodes from the banks of still running water. III *Rogerus rajasthanensis* n. sp. sub family Cyllindrolaiminae and *Monhystrella gracilis* n. sp. Monhysterinae from India. – *Nematologica*, **12** : 403-408.
- Khosla, S.C. 1973. Stratigraphy and microfauna of the Eocene beds of Rajasthan. *J. Geol. Soc. India*, **14**(2) : 142-152.
- Krishna, D and Menon, C.B. 1958. A note on the fishes of Jodhpur (Rajasthan) (In Hindi) *Vijnana Parishad Anusandhan Patrika*, **1**(4) : 207-209.
- Kumar, C.R.A. and Asthana, A. 1993. Fish fauna of Rajasthan. *Indian Review of Life Sciences*, **13** : 133-148.
- Kumar, Sanjeev and Rathore, N.S. 1999. Faunal diversity and State of Health of Pichola Lake, Udaipur-A cases study. In: International Conference on Tropical Aquatic Ecosystems: Health, Management and Conservation, Nainital, India October, 25-30, 1999. Abstract : 86.
- Kumar, Seema and Ahmed, S.I. 1998. New distributional record of *Lymnaea* (Pseudoisuccinea) *acuminata* F. *typica* (Lamarck) (Mollusca : Gastropoda : Lymnaeidae) from the Thar Desert (Rajasthan). *Indian Forester*, **124**(1) : 77-78.
- Kushwaha, K.S., Noor, A. and Joshi, F.L. 1975. Investigation on the control of tropical freshwater crab, *Paratelphusa jacquemontii* Rathbun in the Chambal Command area, Kota (Rajasthan, India). *Pesticides Res. Worker's Assoc.*, Rajasthan, Memoir No. **1** : 1-13.
- Liaquat, Fatima 1996. Studies on toxicity and bioaccumulation of zinc in selected freshwater animals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.

- Mahajan, C.L., Arora, N.K., Sharma, S.D. and Sharma, S.P. 1982. Protozoan fauna of a wetland ecosystem (Bharatpur Bird Sanctuary) during drought conditions. *Int. J. Ecol. Environ. Sci.*, 7 : 131-138.
- Mahajan, C.L., Sharma, S.P., Sharma, S.D. and Arora, N.K. 1982a. Changes in zooplankton population in a wetland ecosystem due to drought. *Int. J. Ecol. Environ. Sci.*, 7 : 139-143.
- Mahajan, C.L., Sharma, S.D., Sharma, S.P. and Arora, N.K. 1982b. Benthic fauna in a wetland ecosystem (Ghana Bird Sanctuary, Bharatpur) during drought conditions. *Int. J. Ecol. Environ. Sci.*, 7 : 145-148.
- Mahajan, K.K. 1969. Fauna of Rajasthan, India. Part 2.- Protozoa (No. 1). *Rec. zool. Surv. India*, 61(3 & 4)[1963] : 377- 401.
- Mahajan, K.K. 1971. Fauna of Rajasthan, India. Part 10 Protozoa (No. 2). *Rec. zool. Surv. India*, 63(1-4) [1965] : 45-76.
- Mahajan, K.K. 1977. Fauna of Rajasthan Protozoa (No. 3). *Rec. zool. Surv. India*, 72(1-4) : 213-225.
- Mansukhani, M.R. and Murthy, T.S.N. 1970. Fauna of Rajasthan, India, Part. 6. Amphibia. *Rec. zool. Surv. India*, [1964] 62(1 & 2) : 51-60.
- Mathur, B.B.L. 1952. Notes on fishes from Rajasthan, India. *Rec. Indian Mus.*, 50(1) : 105-110.
- Mathur, D.S. 1977. On a collection of fishes from Jodhpur District (Rajasthan). *Newslett. zool. Surv. India*, 3(4) : 158-159.
- Mathur, D.S. and Yazdani, G.M. 1970. *Noemacheilus rajasthanicus*, a new species of leach, from Rajasthan. *J. zool. soc. India*, 22(1 & 2) : 97-100.
- Mathur, D.S. and Yazdani, G. M. 1973. Additional record of fish from Jodhpur with a list of species occurring in the district. *Sci and Cult.*, 39(1) : 87-89.
- Mathur, S. N. and Sidhu, N.S. 1957. Occurrence of Apus (Crustacea : Notostraca) in Pilani, Rajasthan. *J. Bombay nat. Hist. Soc.*, 54 : 961-962.
- Meena, Sumitra 2001. Studies on Biodiversity of freshwater zooplankton in Relation to organic Pollution. Ph. D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Misra, S.D., Bhargava, S.C., Dey, T. and Jakher, G.R. 1981. Seasonal study of zooplankton in Balsamand Lake. *Proc. Symp. Eco. Anim. Popul. zool. Surv. India*, Pt. 2 : 19-34.
- Moona, J.C. 1963. Notes on fishes from Bharatpur District Rajasthan. *Rec. Indian Mus.*, 58(2) : 59-66.

- Mukherjee, A.K. 1995. Birds of arid and semi-arid tracts, *Rec. zool. Surv. India, Occ. Paper No. 142* : 1-303.
- Nama H.S. 1987. Helminth parasites from freshwater fishes in Rajasthan. *2nd Int. Symp. Ichthyoparasitology*, Sept. 27 Oct. 3, 1987, Tihany, Hungary : 69 Abt.
- Nayar, C.K.G. 1965. Three new species of Conchostraca (Crustacea : Branchiopoda) from Rajasthan. *Bull. Syst. Zool. Cal.*, 1 : 19-24.
- Nayar, C.K.G. 1968. Rotifer fauna of Rajasthan. *Hydrobiologia*, 31 : 168-185.
- Nayar, C.K.G. 1971. Cladocera of Rajasthan. *Hydrobiologia*, 37(3-4) : 509-518.
- Paliwal, P.P. 1984. An ecological study of Fateh sagar lake (Udaipur) with special reference to macrophytic vegetation.
- Paliwal, P.P. 1988. Geology of Udaipur. Data accessed from Internet.
- Paliwal, P.P. 1998. The Aravallian fluvial sequence of Udaipur city, India : An excellent example of well preserved sedimentary structure in complexity deformed Precambrian metasediments. In : B.S. Paliwal (ed.) *The Indian Precambrian. Scientific Publishers (India), Jodhpur* : 142-158.
- Prasad, M. and Thakur, R.K. 1981. Further additions to the Odonata (Insecta) Fauna of Rajasthan, *Jantu*, 1 : 26-28.
- Rahmani, A.R. 1996. Changing avifauna of the Thar Desert. In : *Faunal Diversity in Thar Desert: Gaps in Research*, (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, Scientific Publishers, Jodhpur, India, 32 : 307-323.
- Rahmani, A.R. 1997a. *Wildlife in the Thar*. New Delhi, Worldwide Fund for Nature, India WWF, New Delhi : 1-100.
- Rahmani, A.R. 1997b. The effect of Indira Gandhi Nahar Project on the avifauna of the Thar Desert. *J. Bombay nat. Hist. Soc.*, 92(2) : 233-266.
- Rahmani, A.R. and Soni, R.G. 1997. Avifaunal changes in the Indian Thar Desert. *J. Arid. Env.*, 36 : 687-703.
- Ramachandran, N.K. and Vijayan, V.S. 1994. Distribution and general ecology of Sarus Crane *Grus antigone* in Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc.*, 91(2) : 211-223.
- Rao, K.S. 1976. Studies on freshwater Bryozoa. IV. The Bryozoa of Rajasthan, India. *Rec. zool. Surv. India*, 69 : 329-345.
- Rao, N.G. and Durve, V.S. 1989. Cultural eutrophication of the lake Rangasagar, Udaipur, Rajasthan, India. *J. Environ. Boil.*, 10(2) : 127-134.

- Rao, N.G. and Durve, V.S. 1992. Structure and dynamics of zooplankton community in lake Rangasagar, Udaipur, Rajasthan, India. *J. Environ. Biol.*, **13**(3) : 343-355.
- Rao, N.G., Durve, V.S. and Shrikhande, V.J. 1988. Concept of planktonic species diversity in small water bodies – a case study of Lake Rangasagar (Udaipur, Rajasthan). *Acta Hydrochem. Hydrobiol.*, **16**(5) : 517-524.
- Rao, R.J. 1986a. *Research on wildlife in the National Chambal Sanctuary*. Wildlife Institute of India. Unpublished report.
- Rao, R.J. 1986b. Freshwater turtle conservation in National Chambal sanctuary. *Tiger Paper*, **13**(3) : 28-29.
- Rao, R.J. 1991. Conservation management of freshwater turtles in the National Chambal Sanctuary. *J. Ecol. Soc.*, **4** : 43-53.
- Rao, R.J. 1995. Nesting ecology of the Gharial in National Chambal Sanctuary. *Zoo Zen.*, **10**(6) : 1-59.
- Rathore, N.S. and Bohra, P. 1987. Mollusc fauna of Lake Kailana (Jodhpur, India). *Oikassay*, **4**(1) : 11-20.
- Ray, H.C. and Mukherjee, A. 1969. Fauna of Rajasthan, India. Part 3. Mollusca. *Rec. zool. Sur. India*, **61**(3 & 4) [1963] : 403-436 pl. 18-20.
- Roonwal, M.L. 1969. Fauna of Rajasthan, India, Part. 1. General Introduction, with a list of collecting localities and a bibliography of Rajasthan Zoology. *Rec. zool. Surv. India*, **61**(3-4)[1963] : 291-376.
- Roonwal, M.L. 1982. Fauna of the Great Indian Desert (Past and Present Composition, Zoogeography, Ecology, Biology, Physiology and Conservation). In: Desert Resources and Technology, (ed.) Alam Singh, *Scientific Publishers and Geotech-Academia, Jodhpur*, Vol. 1 : 1-86.
- Roy, T. 1996. The crustacean fauna of the Thar Desert. In : Faunal Diversity in the Thar Desert: Gaps in Research. (eds.) A.K. Ghosh, Q.H. Baqri, and I. Prakash, *Scientific Publishers, Jodhpur, India*, **12** : 107-112.
- Sankhla, S.K. Shukla, K.B. and Vyas, L.N. 1985. Production pattern in dry bank community of Baghela Lake, Udaipur-B.12. *All India Seminar on Recent Advances in Plant Ecology, Gwalior*.
- Saxena, M.M. 1984. Commercial fishes, their sale and some economic aspects of the trade in the fish market of Jodhpur (Rajasthan, India). *Intr. J. Acad. Ichthyol.*, **5** : 181-182.

- Saxena, M.M. 1988. A survey of Cyclops (Crustacea: Copepoda) population in some water bodies in Rajasthan in relation to the disease dracontiasis. *Abst. Nat. Sem. Adv. Econ. Zool.*, : 93.
- Saxena, M.M. 1996a. Freshwater sponges in the Thar Desert. In : Faunal Diversity in the Thar Desert : Gaps in Research (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, *Scientific Publishers*, Jodhpur, India, 4 : 37-41.
- Saxena, M.M. 1996b. Leech fauna of the Thar Desert. In: Faunal Diversity in the Thar Desert: Gaps in Research (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, *Scientific Publishers*, Jodhpur, India, 8 : 77-80.
- Saxena, M.M. 1998. Faunal diversity in the waters of the Indian desert and need for its conservation. *Abst. Nat. Sem. Management of Natural Resources of Rajasthan, Bikaner* : 51.
- Saxena, M.M. and Baskaran, S. 1981. Diurnal rhythm in physical, chemical and zooplanktonic components in a polluted water tank, Gulab Sagar (Jodhpur). *Proc. Nat. Sympos. Eval. Environ. Spl. Vol. Geobios*, 86-90.
- Saxena, M.M. and Bhargava, S.C. 1980. Macro-benthic fauna of Umaid Place pond, Jodhpur. *Trans. Isdt. and Ucds.*, 5(2) : 48-50.
- Saxena, M.M. and Bhargava, S.C. 1981. Population ecology of two ponds of Jodhpur (Rajasthan) with special reference to planktonic fauna. *Jantu*, 1 : 6-11.
- Saxena, M.M. and Rathore, N.S. 1995. Sewage fish culture in desert town Bikaner : A case study. *Deco Mirror*, 2(4) : 45-48.
- Saxena, V.S. 1989. Wetlands and their management as wildfowl habitats. In : Wetland Conservation. (eds.) L.N. Vyas and R.K. Garg, *Env. Community Centre*, Udaipur : 49-68.
- Scott, D.A. 1989. A Directory of Asian Wetlands. IUCN, Gland, Switzerland and Cambridge.
- Selvray, Selestine 1992. Studies on zinc, lead and cadmium toxicity to selected freshwater Zooplankton. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Sharma, Arvind 1991. Toxic effect of zinc and cadmium on embryonic development of selected freshwater Fishes. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Sharma, K.P. and Johal, M.S. 1982. On the fish and fisheries of Jaisamand Lake, Rajasthan, India. *Vest cs. Spolec. Zool.*, 46 : 56-69.
- Sharma, K.P. and Kulshreshta, S.D. 1991. Fishes and fisheries of Kota district, Rajasthan. *J. Zool. Soc. India*, 33 : 63-70.

- Sharma, K.P., Tyagi, A.P. and Saxena, Ranjana. 1984. Fisheries potential of the Thar Desert, India. *Proc. Sem. Eff. Pest. Aq. Fau.*, : 91-97.
- Sharma, L.L. 1980. Some limnological aspects of Udaipur waters in comparison to selected waters of Rajasthan. Ph.D Thesis from University of Udaipur, Udaipur : 1-251.
- Sharma, L.L. 1998. Life support system of water bodies. In : Reviving wetlands, Issues and challenges. (ed.) S.K. Verma. Himanshu Publications, Udaipur : 95-98.
- Sharma, L.L. Vyas, R.N. and Sharma, S.K. 1992. Total zooplankton, productivity and bacterial loading in five man-made lakes of Udaipur, Rajasthan. Project Report.
- Sharma, M.S. 1980. Studies on Plankton and productivity of Udaipur waters in comparison to the selected waters of Rajasthan. Ph.D Thesis from University of Udaipur, Udaipur. : 1-277.
- Sharma, M.S. and Durve, V.S. 1985a. Trophic status and fishery potential of Rajasthan waters. *Proc. Nat. Sympos. Evalu. Environ.* (Spl. Vol. Geobios) (eds.) S.D. Misra, D.N. Sen and I. Ahmed [1981], : 180-186.
- Sharma, M.S. and Durve, V.S. 1985 b. Morphological distribution and behavioural pattern of zooplankton in Rajasthan waters. *J. Anim. Morphol. Physiol.*, **32**(1&2): 161-170.
- Sharma, Ranu 2001. Studies on toxicity of textile effluents to freshwater Zooplankton. Ph. D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Sharma, S.K. 1997. Freshwater snails of Southern Rajasthan. *J. Bombay nat. Hist. Soc.*, **94**(2) : 433-434.
- Sharma, S.K. 1998. Aquatic biota of Rajasthan. In : Reviving wetlands, Issues and challenges. (ed.) S.K. Verma. *Himanshu Publications*, Udaipur : 75-94.
- Shekhawat, S.S. 1983. Ecological study of Swaroop Sagar Lake with special reference to planktonic population and physico-chemical properties of water. Ph.D. Thesis.
- Shukla, K.B. 1986. Hydrobiological studies of Rangsagar Lake, Udaipur (Rajasthan). Ph.D. Thesis.
- Shukla, K.B. and Vyas, L.N. 1986. Eutrophication in Udaipur lakes. Evidences and Prognosis. Abs. 9. National Seminar on Industrial Pollution and Control, Kota.
- Shukla, K.B. Upadhyay, P. and Vyas, L.N. 1986. Effect of Industrial effluents on the Plankton Population. Abs. 11, National Seminar on Industrial Pollution and Control, Kota.
- Soni, R.G. 1994. Checklist of birds of Indira Gandhi Nahar project stage II (Rajasthan). *Indian Forester*, **120**(10) : 929-935.

- Soota, T.D. and Saxena, M.M. 1983. Sponge fauna of some waters of Rajasthan and its ecology. *Trans. Indt. Ucds.*, **8**(2) : 131-133.
- Soota, T.D. and Saxena, M.M. 1984a. Leeches of some waters of Rajasthan and their ecology. *Geobios new Reports*, **3** : 125-127.
- Soota, T.D. and Saxena, M.M. 1984b. Leeches of some waters of the Indian desert and their ecology. *Oikoassay*, **1**(1 & 2) : 29-31.
- Soota, T.D., Baskaran, S. and Saxena, M.M. 1981. Sponges of Lake Kailana (Jodhpur) their ecology with a note on role of sponges as indicators of water quality. (Abstract) *Nat. Sympos. Evo. Environ.*, Jodhpur.
- Soota, T.D., Baskaran, S. and Saxena, M.M. 1983. Sponges of Lake Kailana Jodhpur, Rajasthan and their ecology. *Geobios new Reports*, **2** : 150-152.
- Soota, T.D., Saxena, M.M. and Baskaran, S. 1981. Leeches of arid region of Rajasthan around Jodhpur, and their ecology, (Abstract) *Nat. Sympos. Evo. Environ.*, Jodhpur.
- Soota, T.D., Saxena, M.M. and Baskaran, S. 1982. Leeches of arid region around Jodhpur and their ecology. *Geobios new Reports*, **1** : 136 -138.
- Srivastava, G.K. 1988. *Fauna of India and Adjacent countries*, Dermaptera, **1** : xii + 268. Zoological Survey of India, Kolkata.
- Srivastava, M. and Saxena, M.M. 1999. Diversity of insect fauna in the waters of the Indian Desert: Present status and threat. *Abst. Internat. Conf. Tropical Aquatic Ecosystems : Health, Conservation and management*, Nainital : 139.
- Subba Rao, N.V. 1996. Molluscs in the Thar Desert. In : *Faunal Diversity in Thar Desert: Gaps in Research*, (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, Scientific Publishers, Jodhpur, India, **29** : 277-283.
- Tak, N. 1996. Aquatic beetles of Thar Desert. In : *Faunal Diversity in the Thar Desert: Gaps in Research*, (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, Scientific Publishers, Jodhpur, India, **24** : 221-226.
- Tak, N. and Sewak, R. 1987. On the Collection of aquatic beetles (Coleoptera) from Lake Kailana (Jodhpur, India). *Oikoassay*, **4**(2) : 33-38.
- Tehsin, Raza, 1989. Faunal history of Fatehsagar Lake, Udaipur. In : *Wetland Conservation*. (eds.) L.N. Vyas and R.K. Garg. Environmental Community Centre, Udaipur : 109-117.
- Tewari, D.N. 1994. Mangroves and Wetlands for Conserving Environment. In: *Forest and Environment*. International Book Distributors, Dehradun : 88-99.

- Thakur, R.K. 1985. Field notes on the Odonata around lake Kailana Jodhpur (Rajasthan). *Bull. zool. Surv. India.*, 7 : 143 -147.
- Tikader, B.K. and Sharma, R.C. 1985. Handbook of Indian Testudines, Published by Director, Zoological Survey of India Calcuta.
- Tiwari, K.K. 1951. Indian species of the genus *Apus* (Crustacea : Branchiopoda) with description of two new species. *Rec. Indian Mus.*, 49(2) : 197-205.
- Tiwari, K.K. 1962a. New species of conchostraca (Crustacea: Phyllopoda) from Rajasthan. *Proc. of 1<sup>st</sup> All India Congr. Zool.*, (Jodhpur, 1959). Part-2, 180-190.
- Tiwari, K.K. 1962b. Occurrence of fossil penaeid prawn in the Fuller's Earth Deposits of Kapurdi (Barmer district, Rajasthan). *Sci. and Cult.*, 28 : 244-245.
- Tiwari, K.K. 1963. Lower tertiary penaeid shrimps from Kapurdi (Barmer district, Rajasthan; India). *Crustaceana*, 5 : 205-212.
- Tiwari, K.K. 1965. *Branchinella kugenumaensis* (Ishikawa, 1894) (Phyllopoda : Anostraca) in Rajasthan, Western India. *Crustaceana*, 9 : 220-222.
- Tiwari, K.K. 1966. A new species of *Nuculana* Link (Mollusca: Bivalvia) from lower eocene Fuller's Earth Deposit of Kapurdi. Rajasthan (Western India). *Annals and Magazine of Natural History* (Ser. 13), 9 : 161-163.
- Tiwari, K.K. 1968. A new fossil period fish from lower tertiary Fuller's Earth Depositi of Kapurdi, Barmer district, Rajasthan. *J. Zool. Soc. India*, 20 : 95-103.
- Tiwari, K.K. 1996. Branchiopod crustacea of Rajasthan Desert. In: Faunal Diversity in the Thar Desert: Gaps in Research. (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, *Scientific Publishers*, Jodhpur, India, 13 : 113-129.
- Tyagi, B.K. and Miller, P.L. 1991. A note on the Odonata collected in South-Western Rajasthan, India. *Notul. Odonatol.*, 3(8) : 134-135.
- Vazirani, T.G. 1970. Fauna of Rajasthan India. Part-5. Aquatic beetles (Insecta: Coleoptera: Dytiscidae). *Rec. zool. Surv. India*, 62(1 & 2) [1964] : 29-49.
- Vazirani, T.G. 1977. Catalogue of Oriental Dytiscidae. *Rec. zool. Surv. India, Occ. Paper No.*, 6 : 1-111.
- Venkataraman, K. 1988. Cladocera of Keoladeo National Park, Bharatpur, Rajasthan II. New Records 1. *Moinodaphnia machleayii* (King 1853) and *Bosminopsis deitersi* (Richard, 1895). *J. Bombay nat. Hist. Soc.*, 85(1) : 229-233.
- Venkataraman, K. 1990. New records of Cladocera of Keoladeo National Park, Bharatpur, III. *J. Bombay nat. Hist. Soc.*, 87(1) : 166-168.

- Venkataraman, K. 1992a. I. Cladocera of Keoladeo National Park, Bharatpur, and its environs. *J. Bombay nat. Hist. Soc.*, **89**(1) : 17-26.
- Venkataraman, K. 1992b. Cladocera of Keoladeo National Park, Bharatpur-IV. New Records  
1. *Camptocercus* CF. *australis* Sars, 1896 and *Indialona globulosa* (Daday, 1898). *J. Bombay nat. Hist. Soc.*, **89**(2) : 140-142.
- Verma, S.K. 1998a. Lake system of Udaipur. In : *Reviving wetlands, Issues and challenges.* (ed.) S.K. Verma. Himanshu Publications, Udaipur : 46-63.
- Verma, S.K. 1998b. Biological monitoring of wetlands. In : *Reviving wetlands, Issues and challenges.* (ed.) S.K. Verma. Himanshu Publications, Udaipur : 126-136.
- Vyas, H.K. 1996. Insect pests in Indira Gandhi Canal region of the Thar Desert. In: *Faunal Diversity in the Thar Desert: Gaps in Research.* (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash, *Scientific Publishers*, Jodhpur, India, **22** : 203-213.
- Vyas, L.N. 1968. Studies on phytoplankton ecology of Pichhola Lake, Udaipur. *Proc. Symp. Recent adv. Trop. Ecol.*, : 334-347.
- Vyas, L.N. 1986. Ecology and Conservation of Lakes in and around Udaipur (Rajasthan) Final Project MAB Project No. 20/46/81-MAB/ENV-2. Department of Botany, College of Science, Sukhadia University, Udaipur.
- Vyas, L.N. and Kumar, H.D. 1968. Studies on the phytoplankton and other algae of Indrasagar tank, Udaipur, India. *Hydrobiologia*, **31** : 421-434.
- Vyas, R. 1997. Gharial of Chambal. *Rajasthan Sujas*. **6**(3) : 38. (In Hindi).
- Yazdani, G.M. 1996. Fish diversity in the Thar Desert. In : *Faunal Diversity in the Thar Desert: Gaps in Research.* (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash), *Scientific Publishers*, Jodhpur, India, **30** : 285-295.

## Chapter 2

# Limnology



S. Kumar and N.S. Rathore



Investigators recording the physico- chemical parameters at Lake Pichhola

## LIMNOLOGY

**S. KUMAR AND N.S. RATHORE**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### INTRODUCTION

The science of wetlands popularly called limnology involves, besides water, physics, chemistry, considerable study of biota and almost all those entities and communities of earth's environment around it. Water has the main role to play in a wetland ecosystem and being the universal solvent due to polar nature of its molecules, it attracts other charged molecules or ions and therefore plays a significant role in not only absorbing great amount of ionic material but also stabilizes atmospheric temperature due to its high specific heat. In a wetland ecotone, several unique properties of water creates a hydrological cycle resulting not only in formation of clouds but also its vaporization property keeps the temperature of adjoining land area low thereby creating a moist environment for perpetuation of life more prolific and unique.

When the clouds precipitation moves on land and drains through streams and rivers it gets accumulated in earth's depressions both natural and manmade and they are called lakes or more comprehensively wetlands.

The popularly known desert state of Rajasthan has fairly large number of wetlands in central Rajasthan other than long stretches of riverine systems especially of perennial nature represented by rivers like the Chambal and the Mahi in south-east and south along with their numerous drier tributaries providing drainage to most of eastern Rajasthan and the drier Luni and Banas in the west and monsoonal Ghaggar bed in the north. The estimated fresh water potential of Rajasthan is about 1.44 lac hectares most of which lies in the south-eastern region of the state contributing about 1.5 % of the total wetlands resource of the country. Wetlands of Rajasthan have been considered highly productive from the fisheries point of view and among them the most productive lakes are situated in the Udaipur region. Infact the lakes of south-central Rajasthan particularly of Udaipur region are the most picturesque landscape of the nature and hence Udaipur is called city of lakes.

With the change in the land use pattern, rapid industrialization and human settlements, Udaipur lakes are in the process of eutrophication, however, they have been supporting rich faunal diversity and highly productive fisheries since last few decades but off-late the fishery has started showing decline and deterioration in water quality of the lake posing a challenging threat on health of these lakes and thus raising question to biologists and limnologists.

Though abundant knowledge on Indian waters in general is available, the freshwater wetlands of Rajasthan in particular are almost untouched. Only scattered study reports are available on the regional wetlands of which mention can be made of the following:

The limnological work on fresh water reservoirs of Rajasthan have been mainly dealt by Das (1960), Das and Srivastava (1956), Srivastava (1956), Pawha and Mehrotra (1966), Vyas (1968), Vyas and Kumar (1968), Sharma (1974), Sharma and Durve (1974, 1982 and 1991), Misra *et al.*, (1975 a & b), Bohra (1975 a & b, 1976 and 1977 a & b), Bohra and Bhargava (1976 a & b and 1977), Bohra, *et al.* (1978 and 1979), Mathew (1978), Khatri (1984 a, & b), Jakher, *et al.* (1981), Saxena (1982 and 1997), Saxena and Soota (1983), Bhargava and Jakher (1983), Paliwal (1984), Saxena and Bhargava (1984 and 1985), Sudan *et al.* (1984), Saxena and Baskaran (1985), Sharma and Durve (1985a & b), Bhargava and Saxena (1987), Davis and Vander (1988), Gopalarao and Durve (1988), Gopalarao *et al.* (1988), Rao, *et al.*, (1988), Bahura, *et al.* (1989a & b and 1993), Rao and Durve (1989 and 1992), Bahura (1990), Kumar and Sharma (1991), Agarwal, *et al.* (1993), Gupta and Sharma (1994), Gupta, *et al.* (1994), Saint, *et al.* (1994), Sharma and Gupta (1994 a & b), Sharma and Saxena (1994), Sharma and Selvaraj (1994), Sharma and Saxena (1995), Sharma, *et al.* (1995 & ?), Mittal and Saxena (1996), Arora and Saxena (1997), Bharadwaj and Sharma (1998 and 1999), Saxena and Chhabra (1998), Singh and Saxena (1998), Singh Kohli, *et al.* (1998), Dadhich and Saxena (1999 a & b), Saigal and Saxena (1999) and Saxena and Chadha (1999).

Some important research projects and thesis on surface waters of Udaipur have been undertaken by Sharma (1962), Banu (1974), Dashora (1977), Jain (1979), Durve (1980), Khatri (1980), Sharma (1980), Sharma (1980 and 1989), Billore (1981), Kothari (1981), Paliwal (1984), Shaktawat (1984), Vyas (1986), Gautam (1987), Gopalarao (1987), Kumar (1987), Shukla (1987), Upadhyaya (1987), Gupta (1988), Karki (1988), Sharma (1989), Solanki (1989), Anon (1991, 1999 and 2000), Lodha (1992), Purohit, *et al.* (1991), Babel (1992), Singh (1992), Mwachiro (1993), Solomon (1994), Sharma and Vyas (1995) and Mehta (1999).

Biswas (1964, 1965 a & b and 1971), Nayar (1965, 1968 and 1971), Mahajan (1969, 1971, 1977), and Venkataraman (1988, 1990 and 1992 a & b) studied taxonomy of zooplankton of Rajasthan waters. All the above-mentioned works do not give an over all picture of Rajasthan wetlands. The present study was aimed to attempt the detailed investigation of Pichhola Lake, one of the Wetlands of National Importance declared by Ministry of Environment & Forests, Govt of India.

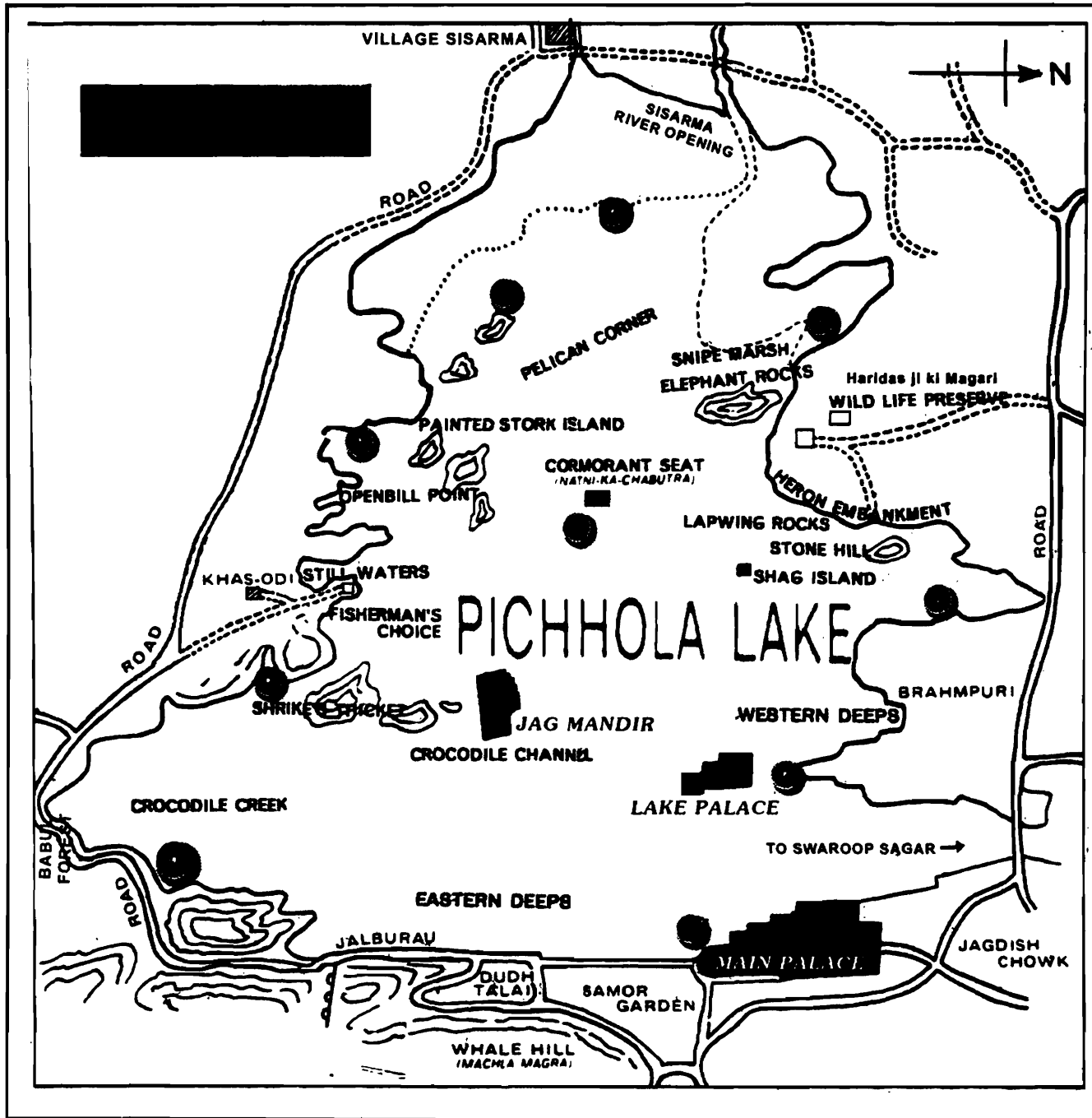


Fig. 1. Map showing sampling sites at Pichhola Lake, Udaipur.

Modified from : Brochure  
Birds & Fishes of  
Pichhola Lake.

## DESCRIPTION OF STUDY AREA

The city of Udaipur (Lat. 24° 35' N Long. 73° 42' E) is located in a hill girdled basin of Aravalli hills in southern Rajasthan by the side of river Ahar, the natural drainage of which is greatly modified by a series of dams forming a chain of lakes and Pichhola is one such manmade lake.

Lake Pichhola is oldest and now the most polluted lake of Udaipur city in the state of Rajasthan. It has a water spread of 10.85 sq. km. with a maximum depth of 9.15 m (Table 1.) The lake is roughly triangular in shape (Fig. 1) with its base along the palace ridge towards the east and is surrounded by high hills on north and west. The lake is a storage type reservoir and receives its water supply through run-off from the catchment area of Aravalli hills and through a seasonal river Sisarma that meets the lake at its western side. The western bank of the lake is progressively getting shallower due to heavy deposition of sediments brought by Sisarma River. On its eastern boundary, the lake Pichhola is connected to the lake Swaroopsagar through a connecting water body called Rangasagar. Whereas on southeastern end, the lake Pichhola is connected with a small but relatively deeper tank called Dudh Talai.

The basin of the lake Pichhola is sloping from north to south slowly tending towards Rangasagar. This narrow portion at the mouth of Rangasagar is silted and the shallowest. The flowage continues faster probably narrowing initially but expanding again to form the lake Swaroopsagar. The vast view of this lake opens into a valley. Thus Pichhola, Rangasagar and Swaroopsagar are joined in a chain.

**Table 1.** General Morphometric features of the Lake Pichhola.

Parameters	Values
Surface area (Sq. Kms.)	10.85
Max. length (Km.)	1.29
Max. breath (Km.)	0.94
Max. depth (m.)	9.15
Average depth (m.)	5.6

Within the lake waters, there are three major establishments. One is a five star hotel called Lake Palace; the other one is the famous historical palace called Jag Mandir Palace and the third one is the non-operational Helipad platform with a small building.

## MATERIAL AND METHODS

The lake was surveyed from 1994 to 1997 all across its length and breadth. In all 50 odd samples of lake water from sub-surface and bottom were collected from 10

sampling stations from all possible water zones except from the channel draining from Pichhola waters to Swaroopsagar. This area was avoided due to heavy human activity on bathing ghats etc. The samples of lake waters were made twice a year for one week to evaluate hydrographic, limnochemical and limnobiological parameters.

For quantitative estimation of zooplankton, 10 litres of surface water was filtered through a plankton net made of bolting silk No. 25. The column and bottom water samples were collected by using St. John's water sampler (Kumar, 1992) and filtered through the same net. Zooplankton numbers were expressed as individuals per litre.

Quantitative study of phytoplanktons was done by filtering 10 litres of lake water through small plankton net. The column and bottom water samples were collected by using St. John's water sampler (Kumar, 1992) and filtered through the same net. Haemocytometer was used to estimate the phytoplankton numbers and counting was done by Sedgwick rafter slide under CZ inverted microscope. The density was expressed as phytoplankton cells per ml. of the sample.

Standard methodology was followed for field collection and analysis work. The physico-chemical measurements for different parameters were made *in situ* by a high precision digital RQflex instrument using Rflectoquant system. The data gathered was than pooled and compared to get an average value parameter wise (Table 2). The whole gamut of physico-chemical parameters have been recorded, the inferences are summarily restricted to a few representative values indicating the physicochemical and trophic status of the lake water as the whole exercise was restricted to a few survey attempts and not the seasonal observation.

**Table 2.** Physicochemical parameters recorded during the year 1994-1997 from Pichhola Lake.

PARAMETERS	2 <sup>nd</sup> week of Sept., 1994	2 <sup>nd</sup> week of March, 1995	4 <sup>th</sup> week of Aug., 1995	4 <sup>th</sup> week of March, 1996	1 <sup>st</sup> week of April, 1997
Air temperature °C	30.0	25.4	30.4	25.9	27.8
Water temperature °C	30.2	26.44	28.2	24.1	25.3
pH	8.3	8.2	8.3	8.4	8.7
Depth of visibility, cm.	52	56	91	54	45
Dissolved O <sub>2</sub> , ppm.	7.2	5.4	7.5	4.1	4.5
Free CO <sub>2</sub> , ppm.	19.2	14.7	16.5	10.9	11.7
Carbonates, ppm	2.4	3.7	5.3	3.1	2.9
Bicarbonates, ppm.	130.0	142.1	132.0	149.2	166.2
Calcium, ppm	22.5	16.9	18.1	15.4	17.2

PARAMETERS	2 <sup>nd</sup> week of Sept., 1994	2 <sup>nd</sup> week of March,1995	4 <sup>th</sup> week of Aug.,1995	4 <sup>th</sup> week of March, 1996	1 <sup>st</sup> week of April, 1997
Magnesium, ppm	10.1	9.0	9.8	8.6	9.6
Silicates, ppm	6.2	2.2	12.6	1.9	1.1
Phosphates, ppm	.219	.122	.435	.125	.136
Nitrates, ppm.	1.021	.078	1.67	.081	.063
Chlorides, ppm.	16.0	19.8	18.5	20.6	22.4
E. C., $\mu$ mhos/cm.	486.2	406.0	461.7	410.2	444.2
Total Phytoplankton (Cell/ml.)	5480	5889	5699	6166	7120
Total Zooplankton (No./ml.)	140	168	205	130	62

## RESULTS AND DISCUSSION

Pichhola Lake is the first wetland in a chain whose overflow drains into a series of subsequent smaller water bodies and finally drains into river Ahar. Pichhola is an age-old wetland and has experienced total drying of its basin during the drought in the summer of 1973. It has experienced considerable change in its hydrobiological composition both due to drought and excessive pressure of all kinds of human activities around it (Durve and Rajbanshi, 1975).

Pichhola waters were found to have high-density of phytoplankton. They were represented by ten species of Chlorophyceae, nine species of Bacillariophyceae, four of Myxophyceae and one species each of Chrysophyceae and Dinophyceae. The blue green algae were the highest followed by the greens and the diatoms, which were mostly recorded in more of stagnant zones. The total phytoplankton count was found to be higher during March-April as compared to count recorded in other periods as shown in (Table 2). The zooplankton population was mainly represented by rotifers, cladocerans, copepods and many insect larval forms. The population abundance was very much fluctuating and found to be insignificant in case of Protozoa, Ostracoda and Decapoda whereas moderate to high population was recorded for rotifers, cladocerans and copepods. The total zooplankton count was 141 no./l.

The light penetration is grossly effected by two factors the dissolved organic/particulate matter and density of phytoplankton population. Though depth of visibility was found to be varying in different water zones of the lake but on an average assessment of visibility factor, it was found to be more during August-September as

compared to March-April. Bohra (1977 a) also reported an inverse relationship between total phytoplankton and depth of visibility during March-April. Phytoplankton affected depth of visibility only during March- April. In the months of monsoon, it was the dissolved organic and particulate matter that contributed to the visibility values. Water clarity of Rajasthan waters have also been worked out by Sharma and Durve (1991). The transparency of water can be directly related to the density of plankton where turbidity due to drainage of soil eroded water is not an important factor. Since the visibility value is approximately 5% of the penetration of solar radiation, it can serve as an index of primary productivity excluding rainy periods (Hutchinson, 1957).

The pH was found to have least variation during all the attempts made in different periods and years. The variations in pH values were very small. This is in confirmation with the view of Welch (1952) that surface waters of large lakes ordinarily undergo relatively small seasonal changes. Blum (1956), Das (1960) and Lakshminarayana (1965) established a direct relationship between phytoplankton and pH values. Such a relationship was also observed in the present study in the months of August-September and March-April.

The alkaline nature of Pichhola Lake is in confirmation with alkaline nature of most of Indian waters as reported by Ganapati (1943), Das and Srivastava (1956), George (1961), Sreenivasan (1964, 1965) and Mathew (1978). Pahwa and Mehrotra (1966) indicated a direct correlation of total alkalinity with pH. Such a direct correlation between pH and total alkalinity as  $\text{CaCO}_3$  was best seen in Pichhola Lake. Barrett (1953) found that hard waters are more productive than soft waters. According to Moyle (1946) alkalinity of 40 ppm appears to be a reasonably good biological dividing line between hard and soft waters. The total alkalinity attained higher values in summer months, which followed a drop in the rainy season. Such an inverse relationship between water level or more correctly dilution and total alkalinity was also reported by Mathew (1978) and Durve, (1980). On this basis Pichhola lake falls in the category of hard waters.

The dissolved oxygen contents were moderately high at times reaching super saturation in the waters under study. Similar low values of dissolved oxygen have been recorded by Verma (1964), Sreenivasan (1966), Sahai and Sinha (1968) and Swarup and Singh (1979). Pearsall (1923) stated that the organic matter or its oxidation needs more oxygen during summer. Further, the solubility of oxygen is low and its loss is more at the higher temperatures. The absence of free carbon dioxide in surface waters is due to its complete utilization by macrophytic vegetation and/or phytoplankton in carbon assimilation and its conversion into mono or bicarbonates (Rawson, 1939).

In 1966, Carbon dioxide in the surface waters of Pichhola varied from 39.2 ppm to 69 ppm during July to June (Vyas, 1968). In present studies, the highest value of free carbon dioxide was only 19.2 ppm (Fig. 2).

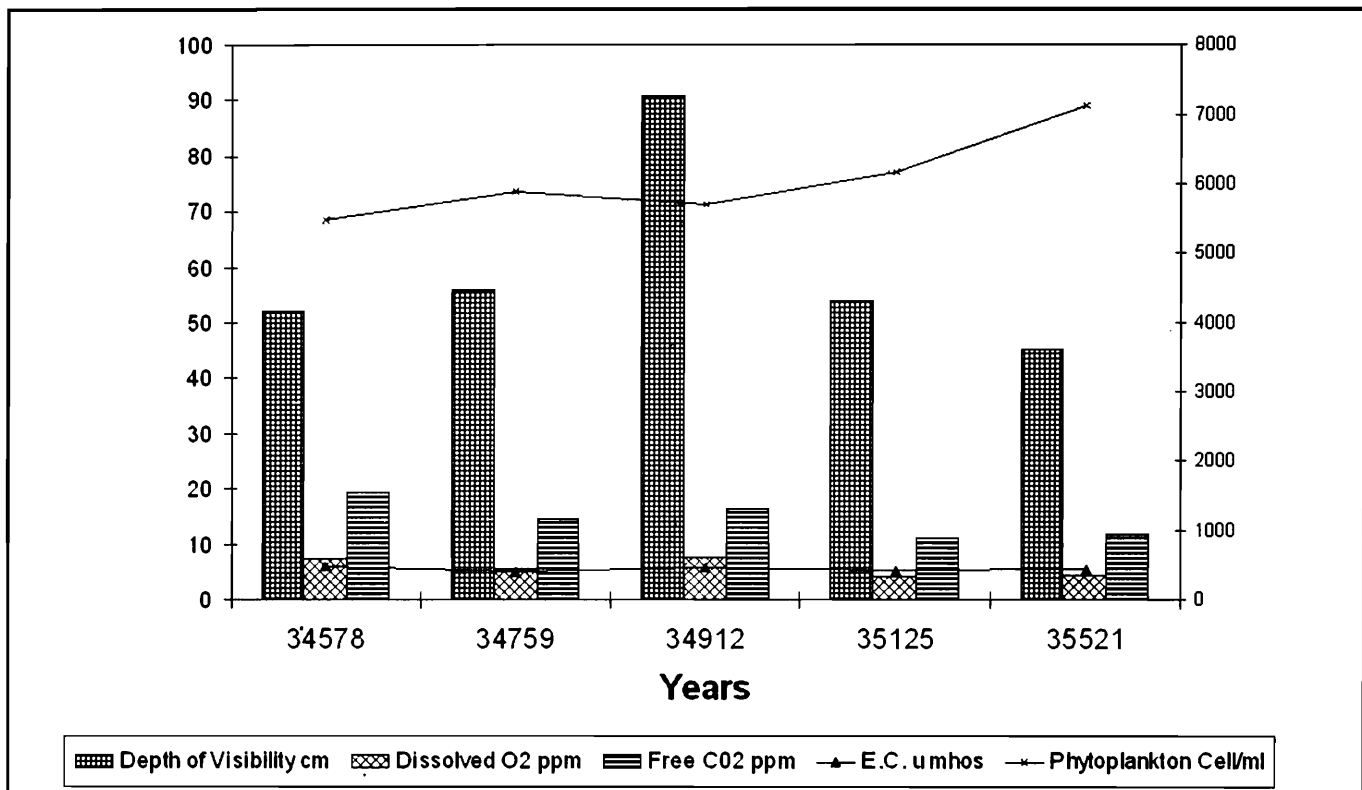


Fig. 2 : Physio-chemical parameters recorded at Pichhola Lake.

The fairly good amount of other dissolved nutrients especially phosphates and nitrates exhibits eutrophic nature of lake. Reid (1961) remarked that in eutrophic lakes the nitrate concentration is typically decreased in the upper zone due to its utilization by plankton. In the present observations, nitrates attained higher values with the incoming run-off waters in Pichhola as stated earlier by Welch (1952), Ruttner (1963) and Blum (1956). The lake Pichhola had fairly good amount of nitrates probably because of the influence of cultural eutrophication and leaching of nutrients from the catchment area.

It is interesting to note that there has not been any significant increase in nitrate in the lake Pichhola since last decade as indicated by the comparison of the present results with those of Vyas (1968). This check over nitrate increase could be due to the luxuriant growth of water hyacinth (*Eichornia crassipes solms*) in most parts of this lake.

Considering the high phytoplankton and submerged vegetation at places, it may be suggested that lake Pichhola could be profitably utilized for stocking phytophagous fishes, which are good biological filters. Further due to high levels of nutrients and consequent higher biomass of algae, the water of Pichhola lake has been said to cause public health hazards (gastric disorders) (Dashora, 1977). It would be beneficial in the public interest to draw drinking water from the underground resources around Lake Pichhola as it was practiced earlier rather than the present system of directly drawing water from the lakes.

Parameters like dissolved oxygen and free carbon dioxide were taken to record the contemporary physiological status of the water at that point of time. No detailed correlation or comparison has been made due to paucity of seasonal and round the year data on these factors. However higher value of free carbon-dioxide in the year 1994 is indicative of high organic pollution in the lake waters and not the result of higher respiratory activities of the organisms as has been phenomenal in such interpretations. More detailed seasonal observations are required for quantification.

Similarly, inorganic elements have also been recorded *in situ* in order to estimate the inorganic constitution of the lake waters as given in Table 1. The electrical conductivity values indicate the high trophic status of the lake waters irrespective of its co-relation with values of a particular ionic content but as a whole high EC value directly indicates Eutrophic nature of the lake this is only with reference to lake system and not comparable with water chemistry of any other water ecosystem such as ground waters which are having high EC value but are not Eutrophic.

### SUMMARY

Pichhola Lake is a good example of cultural eutrophication by way of human activities. With decreasing depth coupled with increased nutrients, Pichhola has shown symptomatic luxuriant growth of water hyacinth. In spite of fairly good amount of nitrates in Pichhola during monsoon, along with sewage effluents adding another factor for high nitrates, there has been no significant rise in the total nitrate budget of this lake probably because of its absorption and loss through removal of water hyacinth.

It had high density of phytoplankton. Zooplankton count was 141 no./l. The pH variations were the least and exhibited alkaline nature of the water. The water is rich in nutrients and consequent higher biomass of algae. The lake is an important visitor attraction and could be profitably utilized for stocking phytophagous fishes, which are good biological filters.

### ACKNOWLEDGEMENTS

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Z.S.I., Kolkata and the Officer-in-charge, Desert Regional Station, Z.S.I., Jodhpur for providing facilities to work on this project of wetlands. Thanks are also due to Dr. V.S. Durve, Rtd. Professor and Dr. M.S. Sharma, Professor, M.L. Sukhadia University, Udaipur for various suggestions and help during the course of our investigation.

## REFERENCES

- Agarwal, R., Bahura, C.K. and Saxena, M.M. 1993. Planktonic productivity of a sewage fish pond and adjoining oxidation pond at Vallabh gardens, Bikaner. *Acta Ecol.*, 15 (1) : 58-61.
- Anon. 1991. Pichhola, Fatehsagar lake Complex wetland conservation awareness programme, Department of Fisheries Science, RCA, Udaipur. Project Report: Project sponsored by Department of Environment, Government of Rajasthan, Jaipur.
- Anon. 1999. *Jalkhumbhi niyantran mai prabhabhi shid ho rahe hai keet. Vaigyanik dal ka akalan, Zheel Sanraksan Samiti, Udaipur* : 1-3.
- Anon. 2000. Desilting of lakes as a boon: A cost-benefit analysis. Unpublished report. pp. 1-16.
- Arora, M. and Saxena, M.M. 1997. Planktonic fauna of a desert pond in relation to certain abiotic factors. *Env. & Ecol.*, 15(2) : 367-36.
- Babel, K. 1992. Water resources of Udaipur Basin. Ph.D. Thesis, Department of Geology, Sukhadia University, Udaipur.
- Bahura, C.K. Bahura, P. and Saxena, M.M. 1989 a. Environmental monitoring of waters of the Indian Desert: Phytoplanktonic productivity in Shivbari temple Tank, Bikaner, with a note on impact of various light wavelengths on it. *Oikoassay*, 6(2) : 87-91.
- Bahura, C.K. Bahura, P. and Saxena, M.M. 1989 b. Environmental monitoring of waters of the Indian Desert: Biotope and Phytoplanktonic community of Shivbari Temple Tank, Bikaner. In: *Perspective in Ecotoxicology* (ed.) N.K. Shastree, Narendra Pub. House, Delhi.
- Bahura, C.K. Bahura, P. and Saxena, M.M. 1993. Environmental monitoring of waters of the Indian Desert: Zooplanktonic community of Shivbari Temple Tank, Bikaner. *J. Ecobiol.*, 5(1) : 5-7.
- Bahura, R. 1990. A planktological survey of some water bodies in and around Bikaner (Rajasthan). M.Phil. Dissertation, Dungar College, Bikaner (India) : 1-64.
- Banu, Nasim. 1974. Municipal water supply in Udaipur city. M.A. Thesis, Department of Geography, Sukhadia University, Udaipur.
- Barrett, P.H. 1953. Relationship between alkalinity and absorption and regeneration of added phosphorous in fertilized trout lakes. *Trans. Amer. Fish Soc.*, 83 : 78-90.

- Bharadwaj, R. and Sharma, L.L. 1998. Biological production in a sewage fed pond of Udaipur (Rajasthan). *Ecol. Env. & Cons.*, 4(4) : 211-214.
- Bharadwaj, R. and Sharma, L.L. 1999. Study of some physico-chemical characteristics of a sewage fertilized seasonal pond of Udaipur (Rajasthan). *Journal of Environment & Pollution*, 6(4) : 255-260.
- Bhargava, S.C. and Jakher, G.R. 1983. Limnological characteristics of some fresh water lakes of arid region of Western Rajasthan, India. *Proc. XXII Cong. Inter nat. Assoc. of Limnology, Lyon, France* :1-383.
- Bhargava, S.C. and Saxena, M.M. 1987. Studies on primary productivity and certain correlative factors in an Indian Desert Reservoir. *Arch. Hydrobiol. Beih. Ergebn. Limnol.*, 28 : 455-461.
- Billore, D.K. 1981. Ecological studies on Pichhola lake, Udaipur. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Biswas, S. 1964. A new species of the Cladoceran genus *Latona* Straus, 1820 (Crustacea: Cladocera: Sididae) from Rajasthan, India. *Proc. zool. Soc.*, 17 : 149-152.
- Biswas, S. 1965 a. Fauna of Rajasthan, India, Part I. Crustacea: Cladocera, *Rec. zool. Surv. India*, 63(1-4) : 96-139.
- Biswas, S. 1965 b. A new species of the genus *Chydorus* Leach, 1843 (Crustacea: Cladocera: Chydoridae) from Rajasthan, India, *Crustaceana*, Leiden, 11(2) : 113-114.
- Biswas, S. 1971. Fauna of Rajasthan India Part II Crustacea: Cladocera. *Rec. zool. Surv. India*, 63 (1-2) : 95-141.
- Blum, J.E. 1956. The ecology of river algae. *Bot. Rev.*, 22 : 291-341.
- Bohra, O.P. 1975 a. Observation on certain hydrological factors of freshwater reservoirs Padamsagar and Rani Sagar, Jodhpur (Raj.). *Geobios*, 2(2 & 3) : 92.
- Bohra, O.P. 1975 b. Freshwater planktons of kailana and two reservoirs of Jodhpur, *Geobios*, 2 (5) : 153.
- Bohra, O.P. 1976. Some aspects of Limnology of Padamsagar and Ranisagar, Jodhpur. Ph.D. Thesis, University of Jodhpur, India.
- Bohra, O.P. 1977 a. Abiotic factors, Chlorophyll pigment and primary production in two lakes of Jodhpur. *Geobios*, (3) : 215-216.
- Bohra, O.P. 1977 b. Comparative Limnology and Primary Productivity of two adjacent lakes, Padamsagar and Ranisagar, in semiarid region of Rajasthan, India. *C.I.F.E. News Letter*, 11 & 12 : 1-15.

- Bohra, O.P. and Bhargava, S.C. 1976 a. Observations on some abiotic components of the Takhat Sagar during winter seasons. *Comp. Physiol. Ecol.*, **1** (1) : 35-36.
- Bohra, O.P. and Bhargava, S.C. 1976 b. Observations on the diel cycle of abiotic parameters at Jatabera, Jodhpur. *Comp. Physiol. Ecol.*, **2** (3) : 115-118.
- Bohra, O.P. and Bhargava, S.C. 1977. Abiotic factors, Chlorophyll pigment and primary production in two lakes of Jodhpur. *Geobios*, **4** (6) : 215-216.
- Bohra, O.P., Mishra, S.D. and Bhargava, S.C. 1978. Occurrence of thermocline in two lakes of semi-arid region in western Rajasthan, India. *Hydrobiologia*, **59** : 203-211.
- Bohra, O.P., Mishra, S.D. and Bhargava, S.C. 1979. Diurnal variation studies on Nakki lake, Mount Abu, India. *Bio-Research*, **3** : 33-43.
- Dadhich, N. and Saxena, M.M. 1999 a. Zooplankton as indicators of trophic status of some desert waters near Bikaner (NW Rajasthan). *J. Env. Poll.*, **6** (4) : 251-254.
- Dadhich, N. and Saxena, M.M. 1999 b. Characterization of trophy of some waters in the Indian desert employing Nygaard's trophic state indices. *Env. & Ecol.*, **17** (2) : 449-451.
- Das, S.M. 1960. Hydrogen ion concentration, plankton and fish in freshwater eutrophic lakes of India. *Nature*, **191** : 4794.
- Das, S.M. and Srivastava, V.K. 1956. Quantitative studies of freshwater plankton II. Correlation between plankton and hydrobiological factors. *Proc. Nat. Acad. Sci. India*, **26** (4) : 243-254.
- Dashora, M.S. 1977. Algae in water supply of Rajasthan. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Davis, C.B. and Vander, V.A. 1988. Ecology of a semitropical monsoonal wetland in India-The Keoladeo Ghana National Park, Bharatpur, Rajasthan. Final Report. Iowa State Univ. Ames., Iowa.
- Durve, V.S. 1980. Hydrobiological and Ichthyological studies on lake Fatehsagar, Rajasthan. (Final report of the ICAR Sponsored project), Department of Limnology and Fisheries Science, R.C.A., Udaipur : 1-74.
- Durve, V.S. and Rajbanshi, V.K. 1975. Fish mortality and fishing during an unprecedented drought in the lake Pichhola, Udaipur. *Indian J. Fish.*, **22** (1 & 2) : 297-299.
- Ganapati, S.V. 1943. An ecological study of garden ponds containing abundant zooplankton. *Proc. Ind. Acad. Sci.*, **17** : 41-58.

- Gautam, Madhu. 1987. Irrigation in Udaipur Basin. Ph.D. Thesis, Department of Geography, Sukhadia University, Udaipur.
- George, M.G. 1961. Diurnal variation in two shallow ponds in Delhi, India. *Hydrobiologia*, 18(3) : 256-273.
- Gopalarao, N. 1987. Synecology of Lake Rangasagar in relation to Limnology and eutrophication. Ph.D. Thesis, Department of Fisheries Science, Rajasthan Ag. University, Bikaner.
- Gopalarao, N. and Durve, V.S. 1988. The probable antagonism in *Brachionus* (Rotatoria) species and Cyanobacteria in a Eutrophic lake of Udaipur, Rajasthan. *J. Environ. Biol.*, 9 (1) : 1-3.
- Gopalarao, N., Durve, V.S and Sharma, L.L. 1988. Morphometric and bathymetric features of four Udaipur lakes. (Rajasthan, India). *J. Hydrobiol.*, IV(1) : 29-31.
- Gupta, M.C. 1988. Some aspects of limnology, primary productivity and Zooplankton of a shallow pond in Udaipur, Rajasthan. M.Sc. (Ag.) Thesis, Rajasthan Agricultural University, Bikaner.
- Gupta, M.C. and Sharma, L.L. 1994. Seasonal variations in selected limno-chemical parameters of Amarchand Reservoir, Southern Rajasthan. *Poll. Res.*, 13(2) : 217-226.
- Gupta, M., Sharan, L. and Saxena, M.M. 1994. Phytoplanktonic productivity of Devikund Sagar village pond (Bikaner: NW Rajasthan). *Acta Ecol.*, 16(1) : 58-62.
- Hutchinson, G.E. 1957. A treatise on Limnology, Vol. I. Geography, Physics and Chemistry, New York : *John Wiley & Sons, Inc.* : 1-1015.
- Jain, S.L. 1979. Primary productivity and energetics of the macrophytic vegetation of Gordhan Vilas tank, Udaipur (South Rajasthan). Ph.D. Thesis, Sukhadia University, Udaipur.
- Jakher, G.R., Dey, T., Misra, S.D. and Bhargava, S.C. 1981. Diurnal Variations in Physico-Chemical factors and zooplankton population in Balsamand Lake, Jodhpur. *Geobios*, 8(3) : 119-122.
- Karki, S.B. 1988. Studies on some limnological aspects of selected closed water ecosystem of Udaipur, India. Ph.D. Thesis. Sukhadia University, Udaipur.
- Khatri, T.C. 1980. Limnological studies of Lakhotia Lake, Pali (Rajasthan). Ph.D. Thesis, University of Jodhpur, Jodhpur (India) : 1-134.
- Khatri, T.C. 1984 a. Diurnal fluctuations in physio-chemical parameters during summer season in Lakhotia Lake of Pali (Rajasthan). *Environ. & Ecol.*, 2 : 95-97.

- Khatri, T. C. 1984 b. Seasonal variation of Dissolved Oxygen in Lakhota Lake. *Environ. & Ecology*, 2(4) : 338-340.
- Kothari, Anita, 1981. Water resources of Udaipur basin. M.A. Thesis, Department of Geography, Sukhadia University, Udaipur.
- Kumar, S. 1987. Certain aspects of water quality of lakes – Pichhola and Fateh Sagar, Udaipur, Rajasthan. M.Sc. Thesis, Rajasthan Agricultural University, Bikaner.
- Kumar, Sanjeev 1992. Description of ST. JOHN'S water Sampler for Limnological investigations. *Geobios New Reports*, 11 : 166-167.
- Kumar, S. and Sharma, L.L. 1991. Comparative physico-chemical limnology of lakes Pichhola and Fatehsagar, Udaipur (Rajasthan). *Poll. Res.*, 10(3) : 173-178.
- Lakshminarayana, J. S. S. 1965. Studies on the phytoplankton of river Ganges, Varanasi, India. *Hydrobiologia*, 25 : 119-165.
- Lodha, R.M. 1992. Location and siting of Industrial activity: a case study of Udaipur city and its environs (1985-1990), Department of Geography, CSSH, Sukhadia University, Udaipur. Project report. Project sponsored by Department of Environment, New Delhi.
- Mahajan, K.K. 1969. Fauna of Rajasthan, India. Part 2. Protozoa (No. 1). *Rec. zool. Surv. India*, 61(3 & 4) [1963] : 377- 401.
- Mahajan, K.K. 1971. Fauna of Rajasthan, India. Part 10. Protozoa (No. 2). *Rec. zool. Surv. India*, 63 (1-4) [1965] : 45-76.
- Mahajan, K.K. 1977. Fauna of Rajasthan Protozoa (No. 3) *Rec. zool. Surv. India*, 72(1-4) : 213-225.
- Mathew, P.M. 1978. Limnological investigations on the plankton of Govindgarh Lake and its correlation with physico-chemical factors. *Proc. Semi. Eco. Fish., Freshwater Reservoirs* : 37-46.
- Mehta, A. 1999. Desilting of lakes as a boon: A cost-benefit analysis. Department of Engineering, College of Techonogy and Agricultural Engineering (Rajasthan Agricultural University, Campus: Udaipur), Udaipur.
- Misra, S.D., Bharagava, S.C. and Bohra, O.P. 1975 a. Diurnal variation in physico-chemical factors at Padamsagar reservoir during premonsoon period of the year 1974. *Geobios*, 12 : 32-35.
- Misra, S.D., Bharagava, S.C. and Bohra, O.P. 1975 b. Diurnal variation in certain hydrological factors and phytoplankton pigments at Padamsagar reservoir, Jodhpur (Raj.). *Trans. Isdt. and Ucds.*, 1 : 18-19.

- Mittal, K. and Saxena, M.M. 1996. Periphyton community of a lotic ecosystem in the Indian desert during winter season. *Env. & Ecol.*, 14(2) : 377-379.
- Moyle, J.B. 1946. Some indices on lake productivity. *Trans. Amer. Fish. Soc.*, 76 : 322-34.
- Mwachiro, E.C. 1993. Limnological evaluation of the lake Bari (Jiyansagar, Udaipur, Rajasthan) as a source of drinking water and fishery, Department of Fisheries Science, Rajasthan Agriculture University, Bikaner.
- Nayar, C.K.G. 1965. Taxonomic notes on the Indian species of *Keratella* (Rotifera). *Hydrobiologia*, 26 : 457-462.
- Nayar, C.K.G. 1968. Rotifer fauna of Rajasthan. *Hydrobiologia*, 31 : 168-185.
- Nayar, C.K.G. 1971. Cladocera of Rajasthan. *Hydrobiologia*, 37 : 509-518.
- Pahwa, D.V. and Mehrotra, S.N. 1966. Observation on fluctuations in the abundance of plankton in relation to certain hydrobiological conditions of river Ganga. *Proc. Nat. Acad. Sci., India, (B)*, 36(11) : 157-189.
- Paliwal, P.P. 1984. An ecological study of Fateh Sagar lake (Udaipur) with special reference to macrophytic vegetation. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Pearsall, W.H. 1923. A theory of diatom periodicity. *J. Mar. Res.*, 11 : 165-185.
- Purohit, R.C., Acharya, M.S. and Babel, M.S. 1991. Sedimentation studies of Fatehsagar and Pichhola lakes, Udaipur (1988-1991), Department of SWC Engineering CTAE, Rajasthan Agriculture University, Udaipur. Project Report: Project sponsored by Ministry of Environment & Forests Government of India, New Delhi.
- Rao, N.G. and Durve, V.S. 1989. Cultural eutrophication of the lake Rangasagar, Udaipur Rajasthan, India. *J. Environ. Boil.*, 10(2) : 127-134.
- Rao, N. G. and Durve, V. S. 1992. Structure and dynamics of zooplankton community in lake Rangasagar, Udaipur Rajasthan, India. *J. Environ. Boil.*, 13(3) : 343-355.
- Rao, N.G., Durve, V. S. and Shrikhande, V.J. 1988. Concept of planktonic species diversity in small water bodies – a case study of lake Rangasagar (Udaipur: Rajasthan). *Acta hydrochim. Hydrobiol.*, 16(5) : 517-524.
- Rawson, D.S. 1939. Some physical and chemical factors in the metabolism of lakes: 9-26. In: Problems of lake biology (ed. F.R. Moulton) *Ann. Assoc. Advance sci. Publ.*, 10.
- Reid, G.K. 1961. Ecology of Inland waters and Estuaries. New York : Reinhold Publ. Corporation : 1-375

- Ruttner, F. 1963. Fundamentals of limnology (Tr. From German, D.G. Frey and F.E.J. Fry) Toronto, University, Press : 1-295.
- Sahai, R. and Sinha, A.B. 1968. Investigations on bio-ecology of inland waters of Gorakhpur (U.P.), India. I. Limnology of Ramgarh Lake. *Hydrobiologia*, **34** (3/4) : 433-47.
- Saigal, D. and Saxena, M.M. 1999. A study on senescence phenomenon in a man-made water sheet in the Indian desert. *Abst. Internat. Conf. Tropical Aquatic Ecosystems: Health, Conservation and management*, Nainital : 140.
- Saint, P.K., Lodha, R.M. and Sharma, L.L. 1994. Hydrogeologic mapping and feasibility of constructed wetlands in water quality management of Udaipur Lakes Basin. Unpublished report.
- Saxena, M.M. 1982. Limnological studies of freshwater reservoirs: Sardarsamand. Ph.D. Thesis, Univ. Jodhpur, Jodhpur (India) 1-122.
- Saxena, M.M. 1997. Hydrozoological diversity of the Aravalli range with special reference to Pushkar valley: Present status and future scope of research. *Abst. Nat. Conf. Env. Eco-dev. Pushkar Valley of Rajasthan*, Ajmer. p. 91.
- Saxena, M.M. and Baskaran, S. 1985. Diurnal rhythm in physical, chemical and zooplanktonic components in a polluted water tank, Gulabsagar (Jodhpur). *Geobios*. (Spl. Vol. 1981) : 86-90.
- Saxena, M.M. and Bhargava, S.C. 1984. Limnological studies on Sardarsamand reservoir: the phytoplankton. *Oikoassay*, 1(1 & 2) : 43-46.
- Saxena, M.M. and Bhargava, S.C. 1985. Studies on the phytopigments and certain correlative factors in an Indian Desert reservoir, *Geobios*, (Spl. Vol. 1981) : 187-190.
- Saxena, M.M. and Chadha, M. 1999. Evaluation of trophic status of desert waters employing different trophic state indices (TSI). *Abst. Internat. Conf. Tropical Aquatic Ecosystems: Health, Conservation and management*, Nainital : 139.
- Saxena, M.M. and Chhabra, C. 1998. Chemical surveillance of drinking water supply in desert city Bikaner (Rajasthan). *Abst. Nat. Sem. Management of Natural Resources of Rajasthan*, Bikaner : 36-37.
- Saxena, M.M. and Soota, T.D. 1983. Gross primary productivity of some waters of the Indian desert. *Trans. Isdt. Ucds.*, **8**(2) : 76-78.
- Schaperclaus, W. 1933. Textbook of pond culture: rearing and keeping of carp trout and allied fishes (Tr. F. Hund). *Fish. Leaflet Wash.*, **311** : 260.
- Shaktawat, S.S. 1984. Ecological studies of Swaroop Sagar lake with special reference to plankton population and physicochemical properties of water. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.

- Sharma, B.L. 1962. Lake irrigation in Udaipur Basin. M.A. Thesis, Department of Geography, Sukhadia University, Udaipur.
- Sharma, L.K. and Saxena, M.M. 1995. The biotope and community of a newly constructed reservoir in the Indian desert. *Acta Ecol.*, 17(2) : 106-108.
- Sharma, L.L. 1974. A simple shallow-water sampler for recording temperature. *Curr. Sci.*, 43(20) : 659-660.
- Sharma, L.L. 1980. Some limnological aspects of Udaipur waters in comparison to selected waters of Rajasthan. A Ph.D Thesis from University of Udaipur, Udaipur : 1-251.
- Sharma, L.L. and Durve, V.S. 1974. A simple shallow water sampler for recording temperature. *Curr Sci.*, 43 (20) : 659-660.
- Sharma, L.L. and Durve, V.S. 1982. Limnology vis-a-vis conservation need of lake Fatehsagar, Udaipur. *Poll. Res.*, 1 (1-2) : 25-29.
- Sharma, L.L., and Durve, V.S. 1991. Water clarity of 26 waters of Rajasthan in relation to phytoplankton. *Proc. 2<sup>nd</sup> Asian fisheries forum, Asian Fisheries Society* (eds.) R. Hirano and I. Hanyu. 915-918 pp.
- Sharma, L.L. and Gupta, M.C. 1994 a. Some aspects of water quality in a shallow pond of Udaipur, Rajasthan. *Rec. zool. Surv. India*, 94(2-4) : 395-402.
- Sharma, L.L. and Gupta, M.C. 1994 b. Some aspects of limnology of Amarchand reservoir, district Rajsamand, Rajasthan : Physical parameters. *Poll. Res.* 13 (2) : 169-179.
- Sharma, L.L., Saini, V.P. and Sharma, S.K. 1995. Mass production of zooplankton using community sewage. *Poll. Res.*, 14(4) : 499-502.
- Sharma, L.L., Saini, V.P. and Sharma, S.K. ? Impact of Human activities on the water quality of Udaipur Lakes : 230-249.
- Sharma, L.L. and Vyas, R.N. 1995. Impact of urban settlement on certain lentic and lotic water bodies of Bearch river system in Girwa and Maveli Tehsils of Udaipur: A Limnological study (1987-91). M.L. Sukhadia University, Udaipur. Project Report: Project sponsored by Department of Science and Technology Government of Rajasthan, Jaipur.
- Sharma, M.S. 1980. Studies on plankton and productivity of Udaipur waters in comparison to selected waters of Rajasthan. Ph.D. Thesis. University of Udaipur, Udaipur : 1-277.

- Sharma, M.S. 1989. Biomonitoring and hazard evaluation of water pollution in and around Udaipur (1987-1989), Department of Zoology, College of Science, Sukhadia University, Udaipur. Project Report: project sponsored by Department of Environment, Government of Rajasthan, Jaipur.
- Sharma, M.S. and Durve, V.S. 1985a. Trophic status and fishery potential of Rajasthan waters. *Proc. Nat. Sympos. Evalu. Environ.* (Spl. Vol. *Geobios*) (eds.) S.D. Misra, D.N. Sen and I. Ahmed, 1985 (1981) : 180-186.
- Sharma, M.S. and Durve, V.S. 1985b. Morphological distribution and behavioural pattern of Zooplankton in Rajasthan waters. *J. Anim. Morphol. Physiol.*, **32**(1 & 2) : 161-170.
- Sharma, M. S. and Selvaraj, C. S. 1994. Zinc, Lead and Cadmium toxicity to selected freshwater zooplankton. *Poll. Res.*, **13**(2) : 191-201.
- Sharma, R. and Saxena, M.M. 1994. Studies on gross and net primary productivity of two bodies of water in the Indian desert. *Acta Ecol.*, **16**(2) : 125-128.
- Shukla, K.B. 1987. Hydrological studies of Rang Sagar lake, Udaipur (Rajasthan), Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Singh Kohli, M.P., Prakash, C. and Jadhav, R.J. 1998. Aquatic productivity indices in four tribal districts of Rajasthan with special reference to fisheries development. *Punjab Fish. Bull.*, **XX**(1) : 53-62.
- Singh, Sunita. 1992. Management of water in Udaipur Basin. Ph.D. Department of Geography, Thesis, Sukhadia University, Udaipur.
- Singh, Y. and Saxena, M.M. 1998. Need for environmental education in the Indian desert in view of local thrust areas. *Abst. Nat. Sem. On Environ. and Educational Development with reference to Indian Desert*, Bikaner : 7.
- Solanki, Sunita. 1989. Potable water supply in Udaipur City. Ph.D. Thesis, Department of Geography, Sukhadia University, Udaipur.
- Solomon, I.J. 1994. Current trends of eutrophication in lake Pichhola and Fateh Sagar, Udaipur. M. Sc. Thesis, Department of Fisheries Science, Rajasthan Agriculture University, Bikaner.
- Sreenivasan, A. 1964. The Limnology, primary production and fish production in a tropical pond. *Limnol. Oceanogr.*, **9** : 391-396.
- Sreenivasan, A. 1965. Limnology of tropical impoundments III. Limnology and production of Amaravati reservoir, Madras state, India, *Hydrobiologia*, **26** : 501-516.
- Sreenivasan, A. 1966. Limnology of tropical impoundment I. Hydrobiological features and fish production in Stanley reservoir, Mettur Dam. *Int. Rev. ges. Hydrobiol.*, **51** (2) : 259-306.

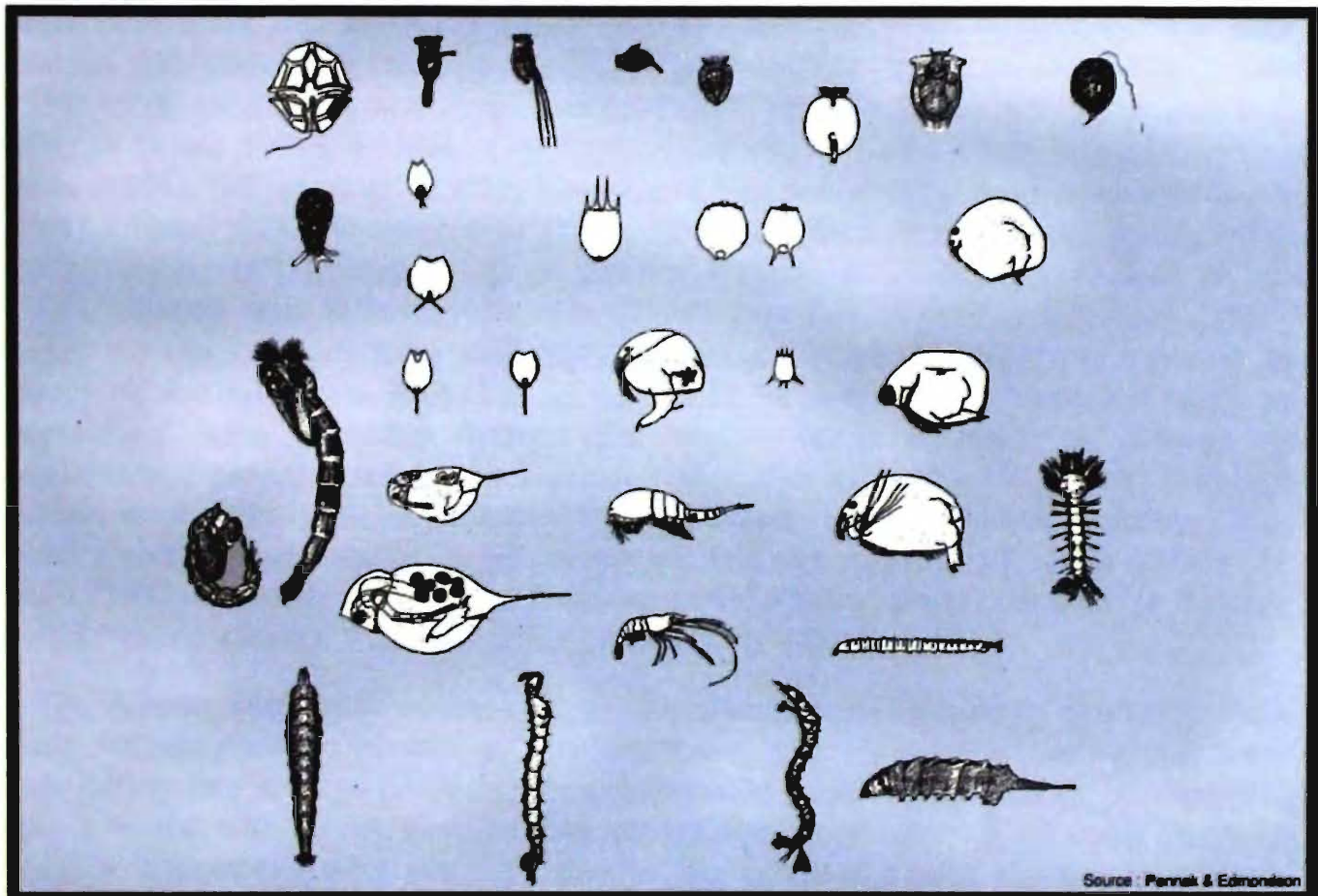
- Srivastava, V.K. 1956. Benthic organisms of a freshwater fish tank. *Curr. Sci.*, **250** : 158-159.
- Sudan, Madhu, Sharma L.L. and Durve, V.S. 1984. Eutrophication of the lake Pichhola in Udaipur. Rajasthan. *Poll. Res.*, **3(2)** : 39-44.
- Swarup, K. and Singh, S.R. 1979. Limnological studies of Suraha lake (Ballia). *J. Inland. Fish. Soc.*, India, **11(1)** : 22-33.
- Upadhyaya, P. 1987. Observations on the planktonic population of lake Fateh Sagar, Udaipur, Rajasthan. Ph.D. Thesis, Department of Botany, Sukhadia University, Udaipur.
- Venkataraman, K. 1988. Cladocera of Keoladeo National Park, Bharatpur, Rajasthan II. New Records 1. *Moinodaphnia machleayii* (King 1853) and *Bosminopsis deitersi* (Richard, 1895). *J. Bombay nat. Hist. Soc.*, **85(1)** : 229-233.
- Venkataraman, K. 1990. New records of Cladocera of Keoladeo National Park, Bharatpur, III. *J. Bombay nat. Hist. Soc.*, **87(1)** : 166-168.
- Venkataraman, K. 1992 a. I. Cladocera of Keoladeo National Park, Bharatpur, and its environs. *J. Bombay nat. Hist. Soc.*, **89(1)** : 17-26.
- Venkataraman, K. 1992 b. Cladocera of Keoladeo National Park, Bharatpur-IV. New Records 1. *Camptocercus* CF. *australis* Sars, 1896 and *Indialona globulosa* (Daday, 1898). *J. Bombay nat. Hist. Soc.*, **89(2)** : 140-142.
- Verma, M. 1964. Hydrobiological survey of Dalsagar tank, Seoni, M.P. India. *Ichthyologica*, **3** : 37-46.
- Vyas, L.N. 1968. Studies on phytoplankton ecology of Pichhola Lake, Udaipur. *Proc. Symp. Recent adv. Trop. Ecol.*, : 334-347.
- Vyas, L.N. 1986. Ecology and conservation of lake in and around Udaipur Rajasthan (1973-1986). Project report, MAB Project No. 20/46/81-MAB/ENV-2, Department of Botany, M.L. Sukhadia University, Udaipur.
- Vyas, L.N. and Kumar, H.D. 1968. Studies on the phytoplankton and other algae of Indrasagar tank, Udaipur, India. *Hydrobiologia*, **31** : 421-434.
- Welch, P.S. 1952. *Limnology*. McGraw Hill book Co. : 1-538.

## Chapter 3

# Zooplankton



S. Kumar and N.S. Rathore



Source: Pennak & Edmondson

Zooplankton composition of Pichhola Lake

## ZOOPLANKTON

**S. KUMAR AND N.S. RATHORE**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### INTRODUCTION

The zooplanktons form the major faunal component of any aquatic ecosystem. They are the secondary producers. The higher hierarchy of animal diversity and their abundance remains entirely dependent on them. The freshwater zooplankton consists mainly of three main groups: the rotifers, the cladocera and the copepoda but in most of the waters, rotifers, limnetic crustaceans along with protozoans and larval insect forms constitutes the dominant component of zooplankton. Zooplanktons and their seasonal variations from freshwater wetlands of Rajasthan have been studied by Tiwari (1951, 1958, 1962, 1965 and 1996), Biswas (1964, 1965a & b and 1971), Nayar (1965, 1968, 1970 and 1971), Mahajan (1969, 1971 and 1977), Deb (1973), Jhingran (1975), Gupta (1976), Jakher, *et al.* (1981), Saxena and Baskaran (1985), Gopal Rao and Durve (1988), Gupta (1988), Venkataraman (1988, 1990 and 1992a & b), Sharma (1991, 1996, 1999), Khatri (1992), Sharma, *et al.* (1992), Bahura, *et al.* (1993), Sharma, *et al.* (1995), Sharma and Vyas (1995), Das (1996) and Roy (1996) and Kumar (2005) worked on zooplanktons from wetlands of Rajasthan. Sharma (1996) have reported 36 species of Rotifers from Rajasthan. Sharma and Selvaraj (1994) studied toxicity in zooplankton from Rajasthan waters. But very little is recorded on account of zooplanktonic groups available in Udaipur lakes. Sharma (1980), Sharma (1980) and Sharma, *et al.* (1992) studied zooplankton of Udaipur waters including Pichhola Lake. Toxicity and bioaccumulation in freshwater animals was studied by Liaquat (1996) and Baber (1997). Toxicity to selected fresh water zooplanktons were studied by Selvray (1992), Meena (2001), Sharma (2001) and Chishty (2002).

The present study was undertaken to record the species diversity and population density of zooplankton present in Pichhola Lake. The zooplankton collections were made during five surveys conducted from September 1994 - August 1997. The samples were collected with 50 cm diameter ring net made up of bolting silk of mesh size 0.33 mm. The collections were made by hauling the net horizontally for few minutes at different collection spots already planned for sample collection. The collected samples were preserved in 4-5 % neutralized formaldehyde and after processing enumerated by

using Sedgewick's rafter counting cell under stereoscopic binocular microscope. Decapods and insect larval forms were counted separately. Zooplankton numbers were expressed as individuals per litre. Taxonomic identification of zooplankton was made after Edmondson (1959), Needham and Needham (1962), Alfred, *et al.* (1973), Mahajan (1969 and 1971), Nayar (1965), Pennak, (1978), Michael and Sharma (1988), Sharma (1999) and Khan (2003).

Protozoans, Rotifers, Ostracods, Copepods, Cladocerans, Decapods and various larval forms of insects mainly constituted the zooplankton population of Pichhola waters. Though considerable differences in diversity and density of zooplankton forms were found at different sampling sites in the lake but their species diversity has been recorded as representative faunal elements and density as average population in the lake waters.

Systematic list of free-living zooplankton hitherto recorded from the Pichhola Lake.

### PROTOZOA

Class MASTIGOPHORA  
Order DINOFLAGELLIDA  
Family PERIDINIIDAE  
Genus *Peridinium* Ehrenberg

*Peridinium* sp.

Order EUGLENOIDINA  
Family EUGLENIDAE  
Genus *Phacus* Dujardin

*Phacus* sp.

Class SARCODINA  
Order TESTACEA  
Family ARCELLIDAE  
Genus *Arcella* Ehrenberg

*Arcella* sp.

Family DIFFLUGIIDAE  
Genus *Diffflugia* Leclerc

*Diffflugia* sp.

### ROTIFERA

Subclass EUROTATORIA  
Superorder MONOGONONTA  
Order FLOSCULARIACEAE

Family CONOCHILIDAE  
Genus *Conochilus* Hlava 1908

*Conochilus* sp.

Order PLOIMIDA  
Family BRACHIONIDAE  
Subfamily BRACHIONINAE  
Genus *Brachionus* Pallas 1907

*Brachionus angularis* Gosse  
*Brachionus calyciflorus* Pallas  
*Brachionus caudatus* Borrois and Daday  
*Brachionus diversicornis* (Daday)  
*Brachionus falcatus* Ahlstrom  
*Brachionus forficula* Wierzeski  
*Brachionus rubens* Ehrenberg  
*Brachionus quadridentata* Hermann

Genus *Keratella* Bory de St. Vincent 1907

*Keratella tropica* (Apstein)

Genus *Platylas* Haring 1913

*Platylas* sp.

Family COLURELLIDAE  
Subfamily COLURINAE  
Genus *Lepadella* Bory de St. Vincent 1907

*Lepadella patella* (Müller)

Family LECANIDAE  
Genus *Lecane* Nitzsch 1907

*Lecane (Luna) luna* (Müller)

Genus *Monostyla* Ehrenberg 1834

*Monostyla bamata* Haring and Myers

Family ASPLANCHNIDAE  
Genus *Asplanchna* Gosse 1850

*Asplanchna* sp.

Family SYNCHAETIDAE  
Genus *Polyarthra* Ehrenberg 1834

*Polyarthra* sp.

Order FLOSCULARIACEA  
 Suborder GNESIOTROCHA  
 Family HEXARTHRIDAE  
 Genus *Hexarthra* Schmarda 1854

*Hexarthra mira* Hudson and Gosse

Family FILINIDAE  
 Genus *Filinia* Bory de St. Vincent 1907

*Filinia longiseta* (Ehrenberg)

Family TESTUDINELLIDAE  
 Genus *Testudinella* Bory de St. Vincent 1907

*Testudinella* sp.

### ARTHROPODA

Class CRUSTACEA  
 Subclass BRANCHIOPODA  
 Order CLADOCERA  
 Family DAPHNIDAE  
 Genus *Daphnia* Müller 1785

*Daphnia carinata* King

*Daphnia lumholtzi* Sars

Genus *Ceriodaphnia* Dana 1853

*Ceriodaphnia cornuta* Sars

Genus *Scapholeberis* Schoedler 1858

*Scapholeberis* sp.

Family MACROTHRICIDAE  
 Genus *Macrothrix* Baird 1843

*Macrothrix* sp.

Family CHYDORIDAE  
 Subfamily CHYDORINAE  
 Genus *Alona* Baird 1850

*Alona* sp.

Genus *Pleuroxus* Baird 1843

*Pleuroxus* sp.

Genus *Chydorus* Leach 1843

*Chydorus* sp.

Subclass OSTRACODA  
 Order PODOCOPA  
 Family CYPRIDAE  
 Subfamily CYPRINAE  
 Genus *Cypris* O. F. Muller 1776

*Cypris* sp.

Subclass COPEPODA  
 Order CALANOIDA  
 Family DIAPTOMIDAE  
 Genus *Diaptomus* Westwood 1907

*Diaptomus* sp.

Order CYCLOPOIDA  
 Family CYCLOPIDAE  
 Genus *Cyclops* O.F. Muller 1776

*Cyclops* sp.

Subclass MALACOSTRACA  
 Order DECAPODA  
 Family PALAEMONIDAE  
 Genus *Macrobrachium* Bate 1868

*Macrobrachium kistnensis* (Tiwari)

Family ATYIDAE  
 Genus *Caridina* Bouvier 1908

*Caridina* sp.

## RESULTS AND DISCUSSION

**Protozoa** : Protozoan species were represented by four genera viz. *Peridinium*, *Phacus*, *Arcella* and *Diffugia*. They were found to be <1 no./l. and therefore insignificant.

**Rotifera** : Rotifers were found to be the most dominant component of zooplanktonic population both in terms of diversity and average density. They were mainly represented by twelve genera and nineteen species (Table 1). The genus *Brachionus* was

represented by eight species and had the maximum numbers per liter as compared to other genera.

**Cladocera** : Cladocerans were represented by seven genera and eight species. They constituted sizeable component of the total zooplankton mass with moderate diversity. The density recorded as a group was 144 no./l.

**Ostracoda** : Cyprids were also found to be <2 no./l. and hence holds poor and insignificant density. Although their species diversity was not determined due to lack of expertise but seems to be represented by one species only.

**Table 1** : Composition and average density of Zooplankton in Pichhola Lake estimated during the study period from 1994-1997.

Zooplankton (Species)	Average density no./l. (Sept. 1994 – April, 1997)
<b>PROTOZOA</b>	< 1
<b>Rotifera</b>	
<i>Conochilus</i> sp.	04
<i>Hexarthra mira</i>	09
<i>Filinia longiseta</i>	19
<i>Testudinella</i> sp.	04
<i>Polyarthra</i> sp.	31
<i>Asplanchna</i> sp.	02
<i>Brachionus angularis</i>	60
<i>Brachionus calyciflorus</i>	49
<i>Brachionus caudatus</i>	25
<i>Brachionus diversicornis</i>	34
<i>Brachionus falcatus</i>	32
<i>Brachionus forficula</i>	52
<i>Brachionus rubens</i>	21
<i>Brachionus quadridentata</i>	45
<i>Keratella tropica</i>	72
<i>Platyias</i> sp.	08
<i>Lepadella patella</i>	26
<i>Lecane luna</i>	86
<i>Monostyla bamata</i>	19

Zooplankton (Species)	Average density no./l. (Sept. 1994 – April, 1997)
<b>Cladocera</b>	
<i>Daphnia carinata</i>	04
<i>Daphnia lumholtzi</i>	02
<i>Ceriodaphnia cornuta</i>	62
<i>Macrothrix</i> sp.	30
<i>Scapholeberis</i> sp.	16
<i>Alona</i> sp.	18
<i>Pleuroxus</i> sp.	08
<i>Chydorus</i> sp.	04
<b>Ostracoda</b>	
Cyprids	< 2
<b>Copepoda</b>	
Calanids	14
Nauplii	21
<i>Cyclops</i> sp.	192
<b>Decapoda</b>	
Shrimps	< 2
<b>Insecta</b>	10

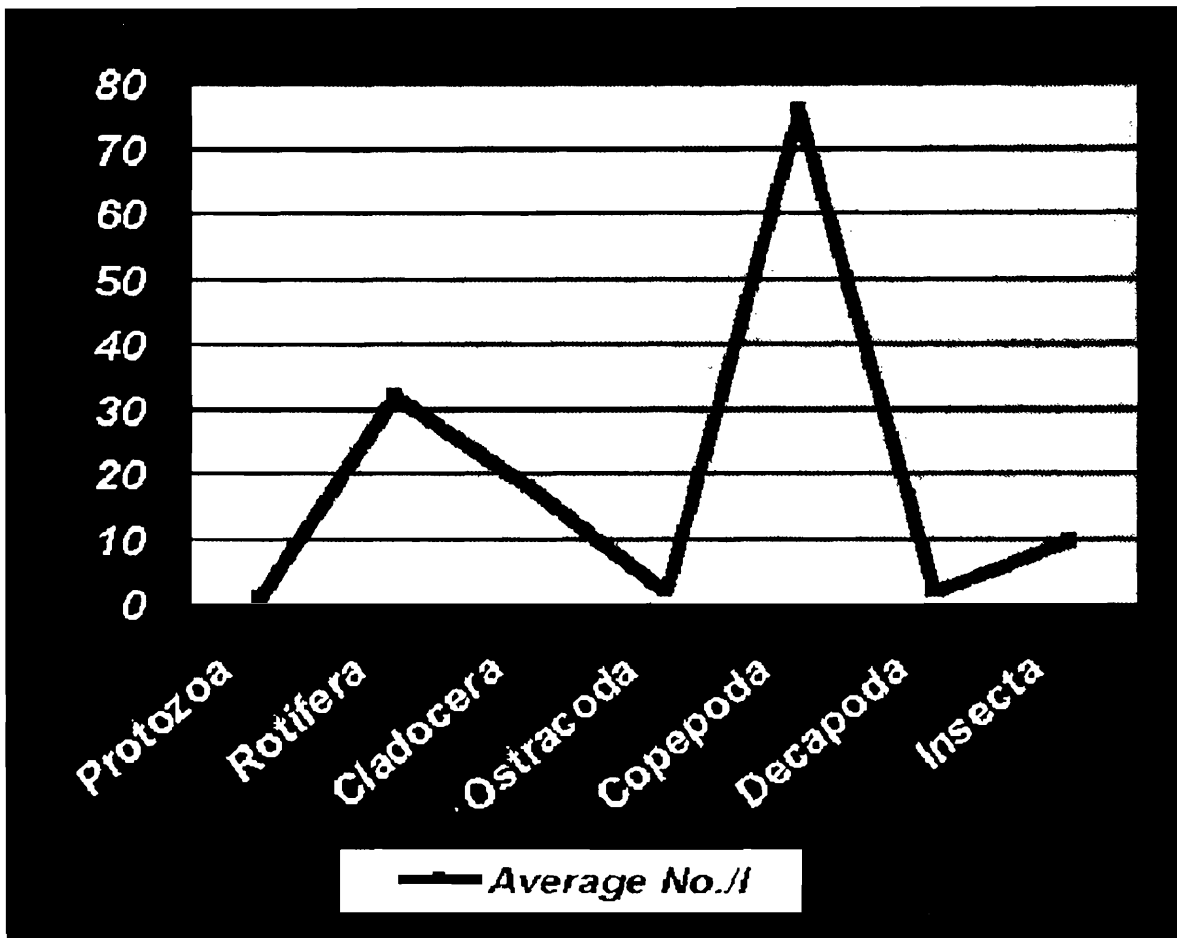
**Copepoda** : Copepods were important components of zooplankton mass represented by calanoids, its nauplii and cyclops. They were regular in occurrence more or less uniformly distributed throughout the lake waters and even dominated certain sampling sites. The population of nauplii (21 no./l.) was found to be more than adult forms (14 no./l.), which were determined mainly as *Diaptomus* sp. The Cyclops were found to be most abundant forms of zooplankton mass regularly occurring in all sampling sites with a uniformly higher density, the average being 192 no./l.

**Decapoda** : Decapods were represented by two genera *Caridina* sp. and *Macrobrachium* sp. The population of *Caridina* sp. were found to be more than *Macrobrachium kistnensis* (Tewari) but as a group they were < 2 no./l.

**Insecta** : Insecta was represented by a density of 10 no./l. including larvae of Diptera (Chironomidae, Psychodidae and Culicidae), Hemiptera and nymphs of dragon and damselflies.

**SUMMARY**

Rotifera were the most dominant group of zooplankton reported from Pichhola Lake represented by nineteen species and twelve genera belonging to nine families. Copepods though an important component of zooplankton mass was represented by two genera under two family regularly occurring throughout the study period. Nauplii were the most regular zooplankton component. Cladocerans though less in average density than the rotifers and the copepods formed a sizeable part of total zooplankton mass represented by seven genera and eight species belonging to three families. Protozoa and Ostracods were almost negligible and hence considered insignificant. Decapoda though negligible were represented by two shrimp species (Fig.1). Insecta was represented by a density of 10 no./l. including larvae of Diptera, Hemiptera and nymphs of Odonate flies.



**Fig. 1 :** Average Population density of Zooplankton groups

### ACKNOWLEDGEMENTS

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Z.S.I., Kolkata and the Officer-in-charge, Desert Regional Station, Z.S.I., Jodhpur for providing facilities to work on this project of wetlands. Thanks are also due to Dr. P. Mathur, M.D.S University, Ajmer for confirming the species identification of rotifers and Dr. S. K. Ghosh, Scientist ZSI, Kolkata for identification of Decapoda.

### REFERENCES

- Alfred, J.R.B., Bernia, S., Lambert, I.M., Michael, R.G., Rajendran, M., Royan, J.P., Sumitra, V., and Wycliffe, J. 1973. A guide to the study of fresh-water organisms. *J. Madurai Univ. Suppl.*, 1-185.
- Bahura, C.K. Bahura, P. and Saxena, M.M. 1993. Environmental monitoring of waters of the Indian Desert: Zooplanktonic community of Shivbari Temple Tank, Bikaner. *J. Ecobiol.*, 5(1) : 5-7.
- Barber, D. 1997. Studies on toxicity and bioaccumulation of cadmium in selected freshwater animals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Biswas, S. 1964. A new species of the Cladoceran genus *Latona* Straus, 1820 (Crustacea: Cladocera: Sididae) from Rajasthan, India. *Proc. zool. Soc.*, 17 : 149-152.
- Biswas, S. 1965a. Fauna of Rajasthan, India, Part I. Crustacea: Cladocera, *Rec. zool. Surv. India*, 63(1-4) : 96-139.
- Biswas, S. 1965b. A new species of the genus *Chydorus* Leach, 1843 (Crustacea: Cladocera: Chydoridae) from Rajasthan, India, *Crustaceana*, Leiden, 11(2) : 113-114.
- Biswas, S. 1971. Fauna of Rajasthan India Part II Crustacea : Cladocera. *Rec. zool. Surv. India*, 63(1-2) : 95-141.
- Chisthty, N. 2002. Studies on Biodiversity of freshwater Zooplankton in relation to toxicity of selected heavy metals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Das, A.K. 1996. Protozoa in the Thar Desert. In : *Faunal Diversity in the Thar Desert: Gaps in Research*. (eds.), A.K. Ghosh, Q.H. Baqri and I. Prakash, Scientific Publishers, Jodhpur, India, 2 : 19-24.
- Deb, M. 1973. Fauna of Rajasthan (India). Crustacea: Ostracoda. *Rec. zool. Surv. India*, 67(1-2)[1969] : 233-259.

- Edmondson, W.T. 1959. Rotifera. In : Fresh-water biology. (2<sup>nd</sup>. Ed.) New York. John Wiley & Sons. Inc., : xvi + 1-1203.
- Gopalrao, N. and Durve, V.S. 1988. The probable antagonism in *Brachionus* (Rotatoria) species and Cyanobacteria in a Eutrophic lake of Udaipur, Rajasthan. *J. Environ. Biol.*, **9**(1) : 1-3.
- Gupta, M.C. 1988. Some aspects of limnology, primary productivity and zooplankton of a shallow pond in Udaipur, Rajasthan. M.Sc. (Ag.) Thesis, Rajasthan Agricultural University, Bikaner.
- Gupta, S.D. 1976. Macrobenthic fauna of Luni reservoir. *J. Inland Fish. Soc. India*, **8** : 49-59.
- Jakher, G.R., Dey. T., Misra, S.D. and Bhargava, S.C. 1981. Diurnal Variations in Physico-Chemical factors and zooplankton population in Balsamand Lake, Jodhpur. *Geobios*, **8**(3) : 119-122.
- Jhingran, V.G. 1975. Fish and Fisheries of India. Hindustan Publ. Corp. (India) : 954.
- Khan, R.A. 2003. Faunal Diversity of Zooplankton in Freshwater Wetlands of Southeastern W.B. *Rec. zool. Surv. India, Occ. Paper No.*, **204** : 1-107. (Published by the Director, *Zool. Surv. India*, Kolkata).
- Khatri, T.C. 1992. Seasonal distribution of Zooplankton in Lakhotia Lake. *Env. and Ecol.*, **10** : 317-322.
- Kumar, Sanjeev. 2005. Zooplankton. In: Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series, **6** : 65-81. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Liaquat, F. 1996. Studies on toxicity and bioaccumulation of zinc in selected freshwater animals. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Mahajan, K.K. 1969. Fauna of Rajasthan, India. Part-2, Protozoa (No. 1). *Rec. zool. Surv. India*, **61**(3 & 4)[1963] : 377- 401.
- Mahajan, K.K. 1971. Fauna of Rajasthan, India. Part-10, Protozoa (No. 2). *Rec. zool. Surv. India*, **63**(1-4) [1965] : 45-76.
- Mahajan, K.K. 1977. Fauna of Rajasthan Protozoa (No. 3). *Rec. zool. Surv. India*, **72**(1-4) : 213-225.
- Meena, S. 2001. Studies on Biodiversity of freshwater zooplankton in Relation to organic Pollution. Ph.D. Thesis. Department of Zoology, M.L. Sukhadia University, Udaipur, Rajasthan.

- Michael, R.G. and Sharma, B.K. 1988. *Fauna of India, Indian Cladocera (Crustacea : Branchiopoda : Cladocera)*. (ed.) Director, ZSI. Technical and General Press, Director Zoological Survey of India, Kolkata : 257.
- Nayar, C.K.G. 1965. Taxonomic notes on the Indian species of *Keratella* (Rotifera) *Hydrobiologia*, **26** : 457-462.
- Nayar, C.K.G. 1968. Rotifer fauna of Rajasthan. *Hydrobiologia*, **37** : 509-518.
- Nayar, C.K.G. 1970. Studies on the rotifer population of two ponds at Pilani, Rajasthan. *J. zool. Soc. India*, **22** : 168-185.
- Nayar, C. K. G. 1971. Cladocera of Rajasthan. *Hydrobiologia*, **31** : 168-518.
- Needham, J.C. and Needham, P.R. 1962. A guide to the study of fresh water biology. Holden-Day Inc. San. Francisco : 106 p.
- Pennak, R.W. 1978. Fresh-water Invertebrates of the United States. 2<sup>nd</sup> Edition. Wiley-Interscience : xv + 1-783.
- Roy, T. 1996. The crustacean fauna of the Thar Desert. In : *Faunal Diversity in the Thar Desert: Gaps in Research*. (eds.) A.K. Ghosh, Q.H. Baqri, and I. Prakash, Scientific Publishers, Jodhpur, India. **12** : 107-112.
- Saxena, M.M. and Baskaran, S. 1985. Diurnal rhythm in physical, chemical and zooplanktonic components in a polluted water tank, Gulabsagar (Jodhpur). *Geobios*. (Spl. Vol. 1981) : 86-90.
- Selvray, S. 1992. Studies on zinc, lead and cadmium toxicity to selected freshwater Zooplankton. Ph. D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.
- Sharma, L.L. and Vyas, R.N. 1995. Impact of urban settlement on certain lentic and lotic water bodies of Beach river system in Girwa and Maveli Tehsils of Udaipur: A Limnological study (1987-91). M.L. Sukhadia University, Udaipur. Project Report: Project sponsored by Department of Science and Technology Government of Rajasthan, Jaipur.
- Sharma, B.K. 1991. Rotifera. In : *Animal Resources of India : Protozoa to Mammals : State of Art*. Zoological Survey of India, Kolkata : 69-88.
- Sharma, B.K. 1996. Biodiversity of freshwater rotifers in India: A status report. *Proc. Zool. Soc.*, Kolkata. **49(2)** : 73-85.
- Sharma, B.K. 1999. Freshwater Rotifers (Rotifera : Eurotatoria). In : *Fauna of West Bengal, State Fauna Series*, **3(Part-1)** [1998] : 341-461. Published by Director, Zoological Survey India, Kolkata.

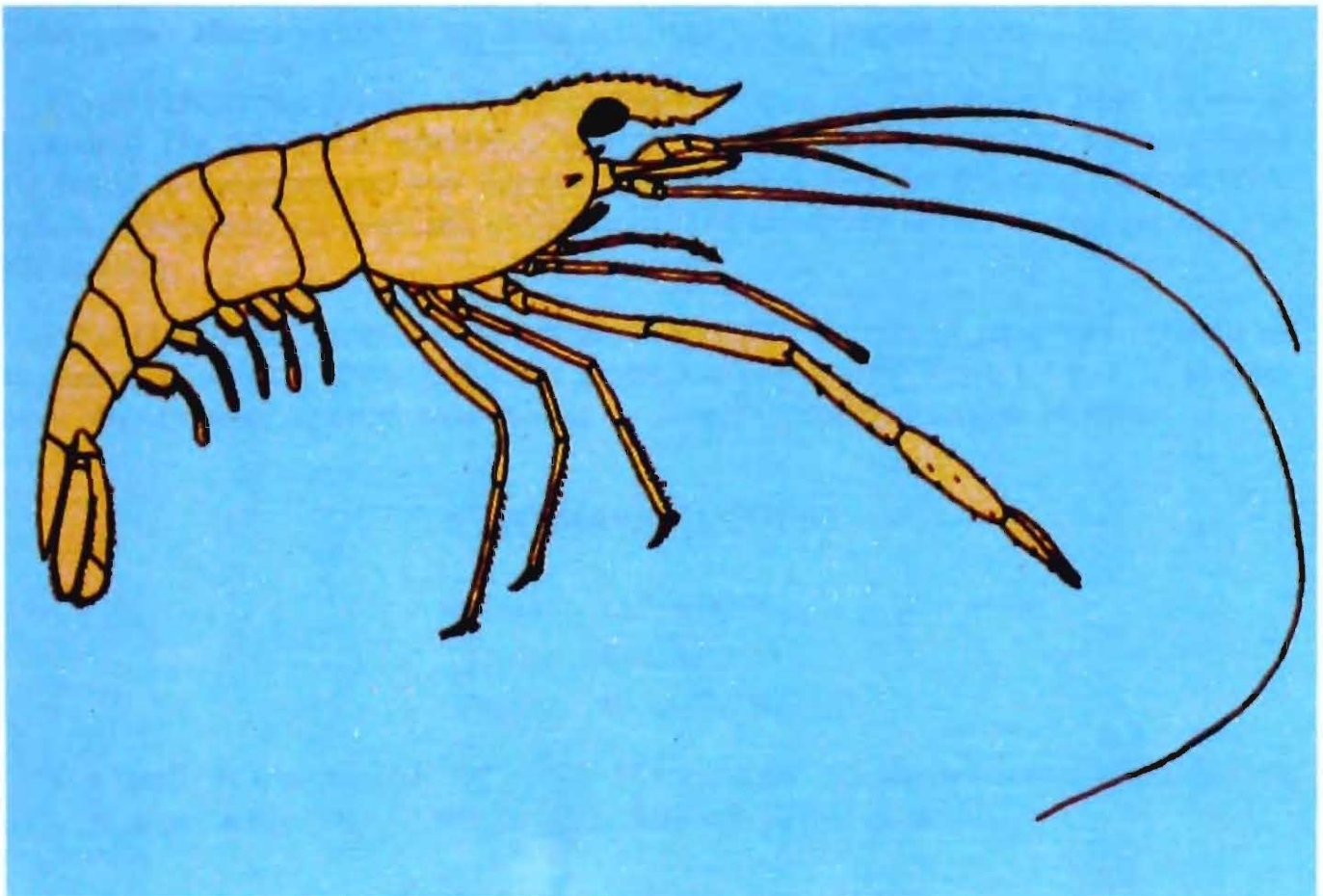
- Sharma, L.L. 1980. Some Limnological aspects of Udaipur waters in comparison to selected waters of Rajasthan. Ph.D. Thesis. University of Udaipur, Udaipur : 1-251.
- Sharma, L.L., Saini, V.P. and Sharma, S.K. 1995. Mass production of zooplankton using community sewage. *Poll. Res.*, **14**(4) : 499-502.
- Sharma, L.L. Vyas, R.N. and Sharma, S.K. 1992. Total zooplankton, productivity and bacterial loading in five man-made lakes of Udaipur, Rajasthan. Project Report.
- Sharma, M.S. 1980. Studies on plankton and productivity of Udaipur waters in comparison to selected waters of Rajasthan. Ph.D. Thesis. University of Udaipur, Udaipur, Rajasthan.
- Sharma, M.S. and Selvaraj, C.S. 1994. Zinc, Lead and Cadmium toxicity to selected freshwater zooplankton, *Poll. Res.*, **13**(2) : 191-201.
- Sharma, R. 2001. Studies on toxicity of textile effluents to freshwater Zooplankton. Ph.D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur, Rajasthan.
- Tiwari, K.K. 1951. Indian species of the genus *Apus* (Crustacea: Branchiopoda) with description of two new species. *Rec. Indian Mus.*, **49**(2) : 197-205.
- Tiwari, K.K. 1958. Diagnosis of a new species of the genus *Branchinella* Sayce (Crustacea: Branchiopoda: Anostraca) from Sambhar Lake, Rajasthan. *J. Bombay nat. Hist. Soc.*, **55** (3) : 585-588.
- Tiwari, K.K. 1962. New species of Conchostraca (Crustacea: Phyllopoada) from Rajasthan. *Proc. 1<sup>st</sup> All India Congr. Zool.* (Jodhpur, 1959), Part-2 : 180-190.
- Tiwari, K.K. 1965. *Branchinella kugenumaensis* (Ishikawa, 1894) (Phyllopoada: Anostraca) in Rajasthan, western India. *Crustaceana*, **9** : 220-222.
- Tiwari, K.K. 1996. Branchiopod Crustacea of Rajasthan Desert. In : *Faunal Diversity in the Thar Desert : Gaps in Research.* (eds.), A.K. Ghosh, Q.H. Baqri and I. Prakash, Scientific Publishers, Jodhpur, **13** : 113-129.
- Venkataraman, K. 1988. Cladocera of Keoladeo National Park, Bharatpur, Rajasthan II. New Records 1. *Moinodaphnia machleayii* (King 1853) and *Bosminopsis deitersi* (Richard, 1895). *J. Bombay nat. Hist. Soc.*, **85**(1) : 229-233.
- Venkataraman, K. 1990. New records of Cladocera of Keoladeo National Park, Bharatpur, III. *J. Bombay nat. Hist. Soc.*, **87**(1) : 166-168.
- Venkataraman, K. 1992 a. I. Cladocera of Keoladeo National Park, Bharatpur, and its environs. *J. Bombay nat. Hist. Soc.*, **89**(1) : 17-26.
- Venkataraman, K. 1992b. Cladocera of Keoladeo National Park, Bharatpur-IV. New Records 1. *Camptocercus* CF. *australis* Sars, 1896 and *Indialona globulosa* (Daday, 1898). *J. Bombay nat. Hist. Soc.*, **89**(2) : 140-142.

## Chapter 4



# Crustacea : Decapoda

Sunil Kumar Ghosh



A fresh water Shrimp

Source : Pennak

## CRUSTACEA : DECAPODA

S.K. GHOSH

Zoological Survey of India, Fire Proof Sprit Building, Kolkata - 700 016

### INTRODUCTION

The study is based mainly on the freshwater prawns collected from Pichhola Lake, Udaipur, Rajasthan. The collected freshwater prawns belong to two groups viz., Atyid and Palaemonid. Atyid group is represented by genus *Caridina* sp. but it is impossible to discuss due to lack of specialist. Only Palaemonid group represented by one species under genus *Macrobrachium* has been described in the present paper.

Tiwari (1955) has described 34 species of the genus *Macrobrachium* from India and Myanmar. The process of adaptation to freshwater is not yet complete, because many are found in estuaries and still depend on brackish waters for breeding. Several have become completely acclimatized to freshwater and are found in inland river regions and hill streams.

Pillai (1990) has mentioned in his paper about 40 species of freshwater prawns of economic value from India under the genus *Macrobrachium* Bate. Of this 15 species have already been reported from Kerala by Jayachandran and Joseph in 1990.

### SYSTEMATIC ACCOUNT

Class CRUSTACEA  
Order DECAPODA  
Family PALAEMONIDAE

The family is characterised by carpus of second pair of pereopods entire; no epipods on legs; upper antennular flagellum bifid; third maxilliped normal.

Genus *Macrobrachium* Bate, 1868

1868. *Macrobrachium* Bate, Proc. Zool. Soc. Lond., : 363.

*Diagnostic characters* : Prawns with rostrum well-developed, compressed and toothed. Carapace armed with antennal and hepatic spines, branchiostegal spine absent, dactylus of last three legs simple.

***Macrobrachium kistnensis* (Tiwari)**

1949. *Palaemon lanchesteri* Tiwari, *Rec. Indian Mus.*, **45** : 340.

1952. *Palaemon kistnensis* Tiwari, *Ann. Mag. nat. Hist.*, **5** : 28.

1988. *Macrobrachium kistnensis* Jalihal, Shenov and Sankolli, *Rec. zool. Surv. India, Occ. Pap. No. 112* : 34.

*Material examined* : 2 exs. 12.iii.1995; 5 exs., 29.iii.1996; 6 exs., 1.iv.1996, coll. N.S. Rathore and S. Kumar.

*Diagnostic characters* : Rostrum extending in between tips of antennular peduncle and antennal scale, usually equal to or slightly extending the antennal scale. Rostral formula 5-10/3-5 with 1 or 2 teeth on carapace behind orbital border. Upper teeth almost equidistant, carapace always longer than rostrum. First pereopods slender, second pereopods comparatively longer and stronger than first. Chela longer than carpus in adult, but it is shorter in young. Carpus longer than merus, palm usually shorter than merus, palm shorter than half of carpus in young, otherwise it is longer in adult. Fingers more than half the length of palm, smooth, non-pubescent with weak teeth near the base. Males always shorter than females, an adult female may be 60 mm in length whereas male being only 46 mm., an egg bearing female measuring more than 40 mm.

*Distribution* : India : Gujarat, Maharashtra, Uttar Pradesh, Madhya Pradesh (Kurian and Sebastian, 1993).

*Elsewhere* : Sri Lanka (Holthuis, 1950).

*Remarks* : Hill stream species extends from Vindhyan satpura range of mountains to Sri Lanka through the Western Ghats.

## SUMMARY

The paper records two genera viz. *Caridina* sp. and *Macrobrachium* sp. of prawns however only one species of *Macrobrachium kistnensis* (Tiwari) is discussed in detail.

## ACKNOWLEDGEMENTS

The author is grateful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata for providing the facilities and also thankful to the Officer-in-charge, Desert Regional Station, Zoological Survey of India, Jodhpur for sending the specimens for identification.

### REFERENCES

- Holthuis, L.B. 1950. The Decapoda of the Siboga Expedition. Part X. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. I. Subfamily Palaemoninae. *Siboga Exped., Monogr.*, **39a**(9) : 1-268.
- Kurian, C.V. and Sebastian, V.O. 1993. *Prawns and Prawn Fisheries of India* : 1-267.
- Pillai, N.N. 1990. *Macrobrachium striatus*: A new species from the Southwest Coast of India. *J. mar. biol. Asso. India.*, **32**(1-2) : 248-253.
- Tiwari, K.K. 1955. Distribution of Indo-Burmese freshwater prawns of the genus *Palaemon* Fabr., and its bearing on the Satpura Hypothesis. *Bull. natn. Inst. Sci. India* No. 7 : 230-239.

## Chapter 5



# Chilopoda : Scolopendromorpha

Vinod Khanna



photo - S. Kumar

A Centipede recorded from Pichhola Lake

## CHILOPODA : SCOLOPENDROMORPHA

VINOD KHANNA

Zoological Survey of India, Northern Regional Station, Dehra Dun

### INTRODUCTION

Centipedes are opisthogoneate chilopods with numerous trunk segments each bearing a single pair of leg. They are generally found under stones, wooden logs, cow dung etc. in the moist areas. All the scolopendromorphs are poisonous animals killing their prey with venom. Indian centipedes including centipedes of Rajasthan have been worked out by Khanna (2001 and 2005).

The present paper deals with a small collection of centipedes collected by the scientists of Desert Regional Station, Zoological Survey of India, from the Pichhola Lake surrounding areas.

### SYSTEMATIC ACCOUNT

Class CHILOPODA  
Order SCOLOPENDROMORPHA  
Family CRYPTOPIDAE

*Paracryptops indicus* Silvestri

1924. *Paracryptops indicus* Silvestri, *Rec. Indian Mus.*, 26 : 74.

*Material examined* : 1 ex., 11.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : Known earlier from Assam (Siju Caves) and Meghalaya.

*Remarks* : This is the first record of the species from Rajasthan.

Family SCOLOPENDRIDAE  
Subfamily SCOLOPENDRINAE  
Tribe **Scolopendrini**

***Cormocephalus pygmaeus* Pocock**

1892. *Cormocephalus (Cormocephalus) pygmaeus* Pocock, *J. Bombay nat. Hist. Soc.*, 7(2) : 140.

*Material examined* : 5 exs., 11.iii.1995, 1 ex., 29.iii.1996, 2 exs., 1.iv.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : Assam, Andaman and Nicobar Islands, Bihar, Maharashtra, Rajasthan, Tamil Nadu and West Bengal (Khanna, 1998).

**Tribe Asanadini*****Asanada indica* Jangi and Dass**

1984. *Asanada indica* Jangi and Dass, *J. Scient. Ind. Res.*, 43(2) : 38-39.

*Material examined* : 1 ex., 2.iv.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : Delhi, Haryana, Himachal Pradesh, Kerala, Maharashtra, Rajasthan and Uttar Pradesh.

**Subfamily OTOSTIGMINAE****Tribe Otostigmini*****Rhysida nuda immarginata* (Porath)**

1876. *Rhysida nuda immarginata* (Porath), *Bih. Svenska acad.*, 4(7) : 24.

*Material examined* : 1 ex., 10.ix.1994; 1 ex., 1.iv.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : Assam, Andaman and Nicobar Islands, Delhi, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and West Bengal.

**SUMMARY**

In all, four species belonging to family Cryptopidae and Scolopendridae have been reported in the present communication. Species *Paracryptops indicus* is a new addition to the Rajasthan fauna, the remaining three are the extension of their records from the state of Rajasthan.

**ACKNOWLEDGEMENTS**

The author is thankful to the Director-In-charge Zoological Survey of India for his kind permission to undertake the study, to Dr. Arun Kumar, Scientist-F, Addl. Director

and Officer-in-charge, Northern Regional Station, Zoological Survey of India, DehraDun for providing necessary facilities and to the Office-in-charge, Desert Regional Station, Zoological Survey of India, Jodhpur for placing the material at my disposal for identification.

#### REFERENCES

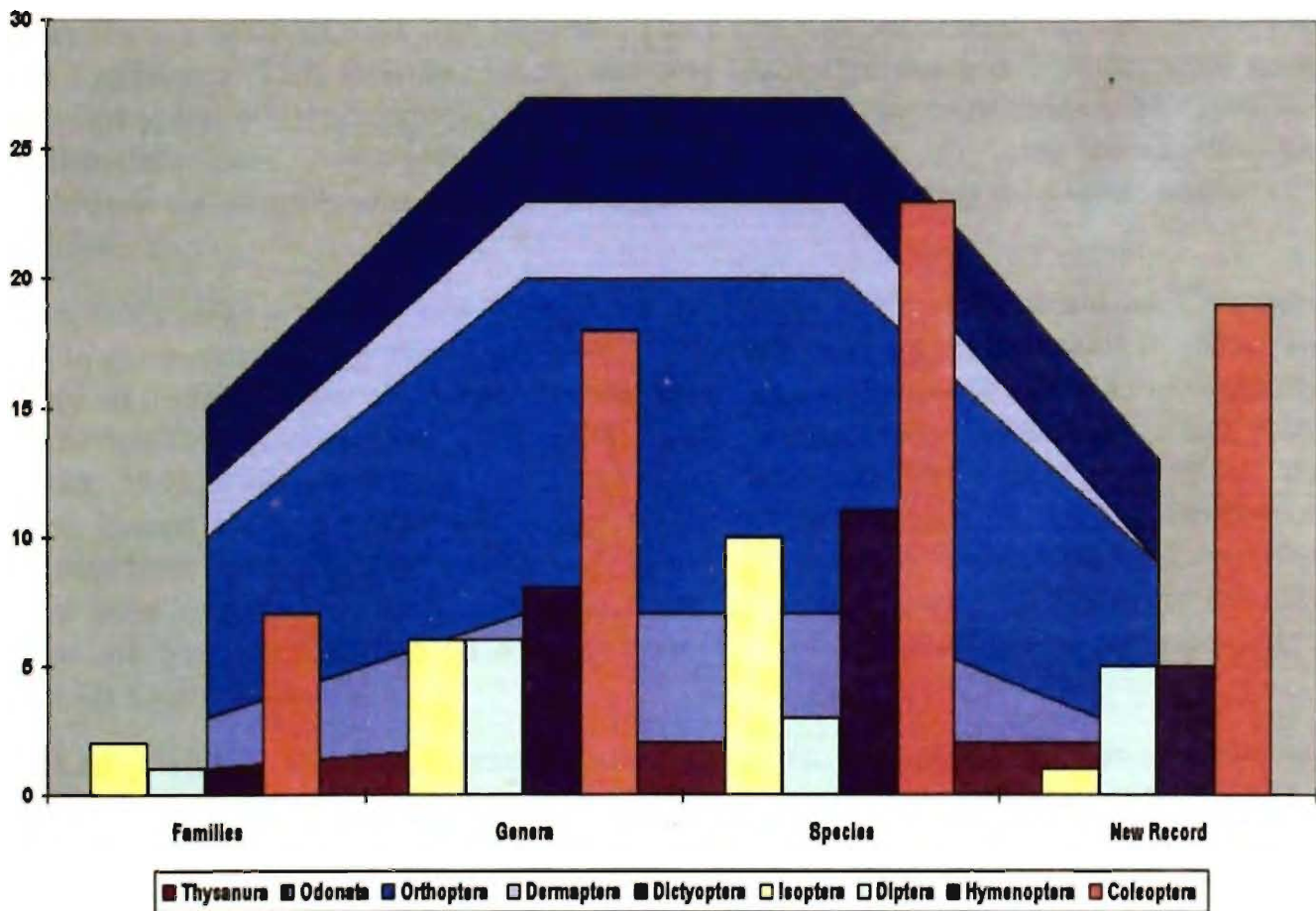
- Khanna, V. 2001. Checklist of the Indian species of the centipedes (Chilopoda : Scolopendromorpha). *Annals of Forestry*. 9(2) : 199-219.
- Khanna, V. 2005. Scolopendromorphs Centipedes of Desert National Park Rajasthan (Chilopoda: Scolopendromorpha). *Rec. zool. Surv. India*, 104(3-4) : 121-127.

# Chapter 6



## Insecta :

<b>Thysanura</b>	A.K. Hazra & M. Biswas
<b>Odonata</b>	M. Prasad
<b>Orthoptera</b>	M.S. Shishodia
<b>Dermaptera</b>	G.K. Srivastava
<b>Dictyoptera</b>	S.K. Mandal & M.S. Shishodia
<b>Isoptera</b>	N.S. Rathore & N. Tak
<b>Diptera</b>	S. Kumar
<b>Hymenoptera</b>	N. Tak, N.S. Rathore & S. Kumar
<b>Coleoptera</b>	P. Mukhopadhyay, S.K. Chakraborty, D.N. Biswas, S.K. Halder, S.K. Ghosh, P. Chakraborty & S. Sengupta



## INSECTA : THYSANURA

A.K. HAZRA AND M. BISWAS

Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053

### INTRODUCTION

The order Thysanura comprises popularly known insects called 'Silver fish' and Bristletail belonging to subclass Apterygota. They are small, soft bodied, fishlike, scaled and wingless insects but considerably larger than the other members of the same subclass. They are easily distinguished by very long many segmented antennae and two anal cerci and single median telson projecting posteriorly from the terminal part of abdomen. The free-living forms are found in the forest floor, under bark of trees, under rocks, in the nests of ants and termites. There are two suborders, *viz.*, Microcoryphia and Zygentoma. Two families, Machilidae and Meinertellidae can be recognised under Microcoryphia while Zygentoma has four families *viz.*, Lepidotrichidae, Nocoletiidae, Lepismatidae and Ateluridae. A few species, such as, *Lepisma saccharina* and *Ctenolepisma longicaudata* cause damage to books, photographs and house hold articles.

A fairly large work has been done from the various parts of the world on Thysanura, but in comparison to the world fauna very little is known on these insects in India. The study of Indian fauna of Thysanura has been neglected except some stray works by Escherich (1905), Silvestri (1913, 1938, 1948), Wygodzinsky (1954, 1972) and Hazra (1980, 1993, 1996) and Hazra *et al.* (1998). Mendes (1990) rightly pointed out that these insects being cryptic in habit; special efforts are needed for their collection. At present from India, 31 species under 21 genera involving 6 families under 2 suborders have been recorded so far. The present study is the first record of this order of insect from the State; it is based on a small collection of 5 examples and includes only 2 species under 2 genera.

Lepismatidae, the family comprehends the most commonly encountered species. They are generally free living, a few are myrmecophilous or termitophilous. They frequently possess hypodermal pigment and the scales of the dorsal surface may form complex pattern. Although most species are tropical or sub-tropical, may have carried some to temperate climate where they survive in shelter provided by their host.

The taxonomy of lepismatids is based to a large extent on the structure and distribution of large, regularly arranged setae, the macrochaetae. These may not be intact in poorly preserved specimens but sockets indicate the place of their insertion. Some experience and adequate optical equipment are necessary to analyze the arrangement of the macrochaetae; in case of doubt, a slide mount of the whole insect or of critical structures must be prepared after dissection.

### SYSTEMATIC ACCOUNT

Order	THYSANURA
Suborder	ZYGENTOMA
Super family	LEPISMATOIDEA
Family	LEPISMATIDAE

Genus *Ctenolepisma* Escherich, 1905

*Ctenolepisma ciliata* (Dufour, 1831)

1831. *Lepisma ciliata* Dufour, *Ann. Sci. Nat.*, **22** : 420.

1905. *Ctenolepisma ciliata*, Escherich, *Zoologica (Stuttgart)* **83** : 80.

1993. *Ctenolepisma ciliata*, Hazra, *Fauna West. Beng.*, **1** (4) : 4.

*Material examined* : 1 ♀, 25.viii.1995, 1♂, 1♀, 9.iii.1995, 1♂, 31.iii.1997, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : Body length 10 mm., width 3 mm. Body elongated, head broad, eyes clearly projecting. Thorax broader than the abdomen; Tergite ix small, half the length of tergite viii; Tertite x is as long as those of ix and vii together, trapezoidal shape, Hypodermal pigment on head, body and appendages; Antennae and cerci shorter than body; abdominal terga ii-vi with 3 + 3 bristle combs; Stylets 2 pairs on viii and ix; ovipositor long and slender.

*Distribution* : India: West Bengal, Delhi, Bihar, Manipur, Sikkim, Rajasthan.

*Remarks* : The species is recorded for the first time from Rajasthan (Udaipur, Pichhola Lake).

Genus *Acrotelsa* Escherich, 1905

*Acrotelsa collaris* (Fabricius, 1793)

1793. *Lepisma collaris* Fabricius, *Ent. Syst.*, **2** : 64.

1913. *Acrotelsa collaris* Silvestri, *Rec. Ind. Mus.*, **9** : 58.

1993. *Acrotelsa collaris*, Hazra, *Fauna West Beng.*, 1 (4) : 5.

*Material examined* : 1♀, 30.iii.1997, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : Body length 16 mm; width 5 mm; body long and robust; base of the body is light yellowish in colour and covered with dark brown scales. The macrochaetae in sub-median field of the head capsule are arranged in a narrow elongated strip, which do not touch the anterior border of the head capsule; The prosternum is covered by the fore coxae from under side. A bunch of solitary macrochaetae is present in the middle of the prosternum. The species can also be recognised by the arrangement of macrochaetae on legs and cerci which are in distinct whirls, this type of arrangement of setae on these appendages are not found in other lepismatids. Tergum x is triangular and sharply pointed with at least 5 pairs of bristle combs; ovipositor with fossorial spines apically on posterior gonapophyses.

*Distribution* : India: West Bengal, Orissa, Bihar and Rajasthan (Udaipur).

*Remarks* : It is here recorded for the first time from the state of Rajasthan (Udaipur). It is a tropicopolitan species and likely to occur in almost all the districts of Rajasthan.

### SUMMARY

The present paper reports two species under two genera belonging to one family of order Thysanura. This order is recorded for the first time from Rajasthan. This report however reflects only part of the knowledge that we have on this group of insects from these areas. Thus there remains ample scope for exploration of more taxa from these regions in future. Extensive and intensive faunistic surveys are required to explore the total fauna of Thysanura.

### ACKNOWLEDGEMENT

We express out sincere thanks to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India for providing laboratory facilities.

### REFERENCES

- Escherich, K. 1905. Das System der Lepismatiden, *Zoologica (Stuttgart)*, 83 : 1-164.
- Hazra, A. K. 1980. On a new species of *Stylifera* (Lepismatidae: Thysanura) from India. *Bull. zool. Surv. India*, 2(2 & 3) : 187-191.
- Hazra, A. K. 1993. Thysanura. *Fauna of West Bengal, State Fauna Series*, 3(Part-4) : 1-17.

- Hazra, A.K. 1996. Thysanura. *Fauna of Delhi, State Fauna Series, 6* : 145-146.
- Hazra, A.K., Biswas, M. and Mitra, S.K. 1998. On some collections of Thysanura from East and Northeast India (in press).
- Mendes, L.F. 1990. On the zoogeographic affinities of the Thysanurans from India. In: *Advances in Management and conservation of soil fauna*, (Eds. G.K. Veeresh *et al.*) 15-26.
- Silvestri, F. 1913. On some Thysanura in the Indian Museum. *Rec. Ind. Mus.*, **9** : 51-52.
- Silvestri, F. 1938. Descriptions of a new *Myrmecophilous lepisma* (Thysanura) from India. *Rec. Indian Mus.*, **40** : 143-145.
- Silvestri, F. 1948. Descrizione di una species note edi una nuova di Lepismatida (Insecta: Thysanura) *Boll. Lab. Ent. Agr. Portici.*, **1** : 100-106.
- Wygodzinsky, P. 1954. Notes and description of Thysanura (Apterygota). *Proc. R. Entomol. Soc.*, London, (B), **23** : 41-46.
- Wygodzinsky, P. 1972. A review of the silver fish (Lepismatidae: Thysanura) of the United States and the Caribbean Area. *Amer. Mus. Nov. No.*, **2481** : 1-26.

## INSECTA : ODONATA

**M. PRASAD**

*Zoological Survey of India, M-Block, New Alipore, Kolkata 700 053*

### INTRODUCTION

Besides, the 'Fauna of British India–Odonata' volumes by Fraser (1933, 1934, 1936), a number of subsequent workers, viz., Agarwal (1957), Bose and Mitra (1976), Prasad and Thakur (1981), Thakur (1985), Tyagi and Miller (1991), Prasad and Varshney (1995) and Prasad (1996, 2004) have reported odonate species from Rajasthan and on account of these a total of 32 species/subspecies are understood to occur there. However, there is no account available on the Odonata fauna of any particular wetland ecosystem of Rajasthan. This paper is based on a small collection of both adults and larvae made from Pichhola Lake, Udaipur. Five species are dealt including the larvae of two species belonging to 5 genera under two families.

### SYSTEMATIC ACCOUNT

Order	ODONATA
Suborder	ZYGOPTERA
Superfamily	COENAGRIONOIDEA
Family	COENAGRIONIDAE

*Ischnura* sp.

*Material examined* : 5 exs. (Larva), 10.iii.1995; 2 exs. (Larva), 12.iii.1995, coll. N. S. Rathore and S. Kumar.

*Distribution* : This genus is cosmopolitan in distribution.

*Remarks* : Determination of species from the larvae of the genus examined was not possible. Larvae of this genus are found on the vegetation present in water both in temporary as well as permanent waterbodies.

***Agriocnemis* sp.**

*Material examined* : 1 ex., (Larva), 10.iii.1995, coll. N. S. Rathore and S. Kumar.

*Distribution* : This genus is distributed in Africa, Australia, China, India, Indonesia, Madagascar, Malaysia, Mauritius, Myanmar, Nepal, New Guinea, Pacific Islands, Philippines, Ryukyu, Seychelles, Sri Lanka, Taiwan and Thailand.

*Remarks* : Species could not be determined from the larva in this case. Larvae of this genus are known to occur in aquatic vegetation inside the water of temporary and permanent waterbodies.

Suborder ANISOPTERA  
Superfamily LIBELLULOIDEA  
Family LIBELLULIDAE

***Bradinopyga geminata* (Rambur)**

1842. *Libellula geminata* Rambur, *Ins. Neurop.*, : 90.

1936. *Bradinopyga geminata* Fraser, *Fauna British India, Odonata*, 3 : 349-350.

*Material examined* : 1 ♂, 9.ix.1994, coll. N. S. Rathore and S. Kumar.

*Measurements* :

Abdomen	Forewing	Hindwing
Male : 27.50 mm.	35.00 mm.	34.00 mm.

*Distribution* : India : Bihar, Eastern Himalayan, Delhi, Gujarat, Madhya Pradesh, Peninsular India, Rajasthan, Uttar Pradesh and West Bengal.

*Remarks* : Membrane brown, its margins white, pterostigma black in centre, but its proximal and distal end white and covers more than 1½ cells. Discoidal cell traversed only once in forewing, but entire in hindwing. Discoidal field begins with 3 rows of cells in forewing and with 2 rows in hindwing. Anal triangle 4 celled in forewing. Only one cubital cell in both the wings. 2 rows of cells present inbetween IRIII & RSPL. Nodal index :

$$\frac{9-11\frac{1}{2}}{9-10} \quad \frac{11\frac{1}{2}-9}{9-10}$$

***Brachythemis contaminata* (Fabricius)**

1793. *Libellula contaminata* Fabricius, *Ent. Syst.*, 2 : 382.

1936. *Brachythemis contaminata* Fraser, *Fauna British India, Odonata*, 3 : 365-366.

*Material examined* : 1 ♂, 2 ♀, 9.ix.1994, 1 ♂, 12.ix.1994, coll. N. S. Rathore and S. Kumar.

*Measurements* :

	Abdomen	Forewing	Hindwing
Male :	19.00 mm.	23.50 mm.	23.00 mm.
Female :	18.00-19.00 mm.	25.00-26.00 mm.	23.00-25.00 mm.

*Distribution* : Throughout India.

*Elsewhere* : Bangladesh, China, Indonesia, Japan, Malaysia, Nepal, Myanmar, Philippines, Singapore, Sri Lanka, Taiwan and Thailand.

*Remarks* : It is one of the most common species in India, which is found almost throughout the year. It is a small sized dragon fly. In male, wings are marked with bright orange fascia from base to within 2/3 cells to pterostigma. The fascia is absent in female.

*Trithemis aurora* (Burmeister)

1839. *Libellula aurora* Burmeister, *Handb. Ent.*, 2 : 859.

1936. *Trithemis aurora* Fraser, *Fauna British India, Odonata*, 3 : 383-385.

*Material examined* : 1 ♂, 9.ix.1994, coll. N. S. Rathore and S. Kumar.

*Measurements* :

	Abdomen	Forewing	Hindwing
Male :	23.00 mm.	28.00 mm.	27.00 mm.

*Distribution* : Throughout India.

*Elsewhere* : China, Hong Kong, Indonesia, Japan, Kampuchia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Tibet and Vietnam.

*Remarks* : Membrane brown in colour, pterostigma dull brownish-yellow and covers approx. 2 cells. Only one cubital nervure in both wings. Discoidal cell traversed only once in both the wings. Discoidal field begins with 3 rows of cells in forewing and

with 2 rows of cells in hindwing. 2 rows of cells present in between IRIII and RSPL.  
Nodal index :

$$\frac{10-11\frac{1}{2}}{12-10} \quad \frac{12\frac{1}{2}-11}{9-11}$$

### SUMMARY

A total of 5 species (including larvae of *Ischnura* sp. and *Agriocnemis* sp.) belonging to 5 genera and two families are recorded from the Pichhola Lake, Udaipur, Rajasthan. Collection data, distributional range, body measurements and notes on taxonomy and field notes have been provided.

### ACKNOWLEDGEMENTS

Author is thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata and the Officer-in-charge, Desert Regional Station, Zoological Survey of India, Jodhpur for providing facilities and opportunity to study this unidentified collection. Thanks are also due to Dr. S. K. Mitra, Scientist- F, Zoological Survey of India, Kolkata for encouragement.

### REFERENCES

- Agarwal, J. P. 1957. Contribution towards the Odonata fauna of Pilani. *Proc. 44<sup>th</sup> Indian Sci. Congr.*, : 309.
- Bose, B. and Mitra, T. R. 1976. The Odonata fauna of Rajasthan. *Rec. zool. Surv. India*, **71** : 1-11.
- Fraser, F. C. 1933. *Fauna of British India-Odonata*. Taylor and Francis, London **1** : 1-423.
- Fraser, F. C. 1934. *Fauna of British India-Odonata*. Taylor and Francis, London **2** : 1-398.
- Fraser, F. C. 1936. *Fauna of British India-Odonata*. Taylor and Francis, London, **3** : 1-461.
- Prasad, M. 1996. Odonata in the Thar Desert: *Faunal diversity in the Thar Desert: Gaps in research* (eds.) A. K. Ghosh, Q. H. Baqri and I. Prakash. Scientific Publishers. Jodhpur. 145-149.
- Prasad, M. 2004. Fauna of Desert National Park (Proposed Biosphere Reserve) Insecta: Odonata. (Edited-Director). *Conservation Area Series*, **19** : 51-58 (Published by the Director, *Zool. Surv. India*, Kolkata).
- Prasad, M. and Thakur, R. K. 1981. Further additions to the Odonata (Insecta) Fauna of Rajasthan, *Jantu*, **1** : 26-28.

- Prasad, M. and Varshney, R. K. 1995. A checklist of the Odonata of India including data on larval studies. *Oriental Ins.*, **29** : 385 - 428.
- Thakur, R. K. 1985. Field notes on the Odonata around lake Kailana Jodhpur (Rajasthan). *Bull. zool. Surv. India*, **7** : 143 -147.
- Tyagi, B. K. and Miller, P. L. 1991. A note on the Odonata collected in Southwestern Rajasthan, India. *Notul. Odonatol.*, **3** : 134-135.



## INSECTA : ORTHOPTERA

**M.S. SHISHODIA**

*Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053*

### INTRODUCTION

Orthoptera includes grasshoppers, crickets, grouse-locusts, bush-crickets etc., and Mantodea contains mantid-commonly known as praying mantids. There is no account available on the Orthoptera and Mantodea fauna of any wetland ecosystem of Rajasthan, except some work of Bhargava (1990 and 1996), Bhowmik (1967, 1969, 1971, 1977 and 1985), Kushwaha and Bharadwaj (1977), Mukherjee *et al.* (1995), Parihar (1987 and 1996), Tandon and Shishodia (1976), Venkatesh (1977) and Shishodia (2004) from Rajasthan State. They have reported a total of 114 species of Orthoptera and 7 species of Mantodea from Rajasthan. Shishodia (2005) have worked on Orthoptera of Sambhar Lake Rajasthan. Present study is based on the small collection of Orthoptera and Mantodea, made from and around Pichhola Lake, Udaipur, Rajasthan. In the present study a total of 13 species of Orthoptera and one species of Mantodea are recorded from Pichhola Lake, of which 7 species of Orthoptera marked by single asterisk (\*) are reported for the first time from Rajasthan.

### SYSTEMATIC ACCOUNT

Order ORTHOPTERA

Family GRYLLIDAE

*Gryllus bimaculatus* De Geer

1773. *Gryllus bimaculatus* De Geer, *Mem. Ins.*, 3 : 531.

1936. *Gryllus bimaculatus* : Chopard, *Ceylon J. Sci.*, (B) 20 : 22.

*Material examined* : 2 ♀, 10.ix.1994, 1 ♂, 10.iii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Body and legs almost glabrous and typically black with yellow spot at base of each tegmen.

*Distribution* : India : Andman and Nicobar Islands, Arunachal Pradesh, Bihar, Delhi, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Pondicherry, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh and West Bengal.

*Elsewhere* : Africa, Malaya, Mediterranean region, Myanmar, Pakistan, Singapore and Sri Lanka (Chopard, 1969 and Blackith, 1992).

***Modicogryllus confirmatus* (Walker)**

1859. *Acheta confirmata* Walker, *Ann. Mag. nat. Hist.*, (3) 4 : 221.

1964. *Modicogryllus confirmatus*: Randell, *Can. Ent.*, 96 : 1584.

*Material examined* : 1 ♀, 12.ix.1994, 1 ♀, 31.iii.1997, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Head brown with narrow yellow band connecting the lateral ocelli; mirror longer than broad, divided by a curved vein; 2 oblique veins; lateral field of tegmina with widely separated veins.

*Distribution* : India : Andman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Bangladesh, Indo-China, Israel, Malaya, Myanmar, Nepal, Sri Lanka and Thailand.

***Plebeigryllus guttiventris* (Walker)\***

1871. *Gryllus guttiventris* Walker, *Cat. Derm. Salt. Brit. Mus.*, 5 : 6.

1964. *Plebeigryllus guttiventris*: Randell, *Can. Ent.*, 96 (12) : 1598.

*Material examined* : 1 ♂, 9.ix.1994; 4 ♂, 9.iii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : General shape short and depressed, head blackish above with short light lines on occiput, posterior femora short and thick, feebly striated with brown.

*Distribution* : India : Bihar, Delhi, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Pondicherry, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Myanmar and Sri Lanka.

***Grylloides sigillatus* (Walker)**

1869. *Gryllus sigillatus* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 46.

1969. *Grylloides sigillatus*: Chopard, *Fauna of India, Orthopt.*, 2 Grylloidea : 85.

*Material examined* : 1 ♂, 9.ix.1994; 2 ♀, 27.viii.1995; 1 ♂, 31.iii.1997, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Head small, a little flattened, frontal rostrum much narrower, tegmina of male not surpassing the middle of abdomen and truncated at apex; female tegmina short and widely separated; wings absent.

*Distribution* : India : Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Malacca, Malaya, Sri Lanka and in all tropical countries.

***Pteronemobius fascipes* (Walker)\***

1869. *Lnaoptera fascipes* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 67.

1931. *Pteronemobius fascipes*: Chopard, *Bull Raffles Mus.*, No. 6 : 134.

*Material examined* : 1 ♂, 9.ix.1994; 1 ♂, 3 ♀, 12.ix.1994; 1 ♂, 25.viii.1995 and 27.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Head blackish with 4 pale lines on occiput; maxillary palpi blackish at base, 4<sup>th</sup> and 5<sup>th</sup> joints white; pronotum brownish above; posterior tibiae with 3 external and 4 internal spines in male.

*Distribution* : India : Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : China, Philippines, Malaya, Myanmar, Sri Lanka and Taiwan.

***Paranemobius pictus* (Saussure)\***

1877. *Pseudonemobius pictus* Saussure, *Mem. Soc. Geneve*, 25 : 67.

1925. *Paranemobius pictus*: Chopard, *Ann. Mag. nat. Hist.*, (9) 15 : 506.

*Material examined* : 1 ♂, 28.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Tegmina over-lapping with each other on the median line of abdomen; internal margin of left tegmen transparent and its apical part a little truncated.

*Distribution* : India : Bihar, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu.

*Elsewhere* : Sri Lanka.

#### Family TRIGONIDIIDAE

##### *Trigonidium cicindeloides* Rambur \*

1839. *Trigonidium cicindeloides* Rambur, *Faune Andal.*, 2 : 39.

1969. *Trigonidium cicindeloides*: Chopard, *Fauna of India*, Orthopt. 2, Grylloidea : 304.

*Material examined* : 1 ♂, 9.ix.1994, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Very small gryllids; colouration black, shining, with posterior legs light yellowish; tegmina strongly convex; wings short; ovipositor compressed, curved and acute at apex.

*Distribution* : India : Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Himachal Pradesh, Karnataka, Madhya Pradesh, Maldiva and Laccadive Archipelagoes, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Africa, Madagascar, Malaya, Mauritius Island, Mediterranean region, Myanmar and Sri Lanka.

#### Family MOGOPLISTIDAE

##### *Ornebius* sp.\*

*Material examined* : 1 nymph, 26.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Small in size, body depressed, pubescent and frontal rostrum narrow, pronotum produced backwards and tegmina brachypterous; anterior tibiae perforated at base of internal face; second segment of posterior tarsi compressed and minute; posterior tibiae with serrulated margins and without spines.

*Distribution* : The genus is distributed in India, Africa, S. Asia, Australia, Central America and Japan.

#### Family GRYLLOTALPIDAE

##### *Gryllotalpa africana* Beauvois

1805. *Gryllotalpa africana* Beauvois, *Ins. Afr. Amer.*, : 229.

1967. *Gryllotalpa africana* Chopard, *Orthopt. Catalogus*, Part 12 : 449.

*Material examined* : 1 nymph, 26.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Anterior legs short, modified for digging purposes; anterior tibiae armed with four dactyls; colour of body dark-brown.

*Distribution* : India : Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Meghalaya, Orissa, Pondicherry, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Africa, Australia, Bhutan, Iran, Madagascar, Malaya, Myanmar, Nepal, Pakistan, Singapore, S. Spain and Sri Lanka.

#### Family TETRIGIDAE

##### *Hedotettix punctatus* Hancock

1908. *Hedotettix punctatus* Hancock, *Trans. ent. Soc. Lond.*, : 422.

*Material examined* : 1 ♀, 27.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Vertex a little narrower than an eye; front margin obtuse angulate; frontal costa narrowly sulcate; pronotum strongly compresso-cristate, front margin distinctly angulate and produced over the head.

*Distribution* : India : Karnataka, Madhya Pradesh, Maharashtra and Rajasthan.

*Elsewhere* : Borneo.

##### *Ergatettix dorsifera* (Walker) \*

1871. *Tettix dorsifera* Walker, *Cat. Derm. Salt. Brit. Mus.*, 5 : 825.

1929. *Ergatettix dorsifera*: Hebard, *Revue suisse Zool.*, 36 : 588.

*Material examined* : 1 ♂, 12.ix.1994, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Vertex very narrow and sufficiently raised above the surface of pronotum; antennae inserted distinctly below the inferior margin of eyes; median carina of pronotum undulate, lateral carinae without dilated lobes on the hind process of pronotum, hind femora with less protuberant tubercles on external surface.

*Distribution* : India : Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

*Elsewhere* : Bangladesh, Central Asia, S. China, Nepal, Sri Lanka, Greater Sunda Islands, Sumba, Taiwan and Turkmenia.

***Pseudoparatettix histricus* (Stal) \***

1860. *Tettix histrica* Stal Freg. *Eugenies Resa Orth.* : 347.

1992. *Pseudoparatettix histricus*: Blackith. *Cat. of S.E. Asian Tetrigidae*, : 149.

*Material examined* : 1 ♂, 3 ♀, 10.xii.1994, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Stature robust and large; head a little exserted; vertex narrower than an eye, truncate in front; frontal costa moderately sulcate; pronotum a little dilated between shoulders, surface smooth, median carina of pronotum arcuate forward, often a little undulate before shoulders, straight behind; posterior tibiae unicoloured.

*Distribution* : India : Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Tamil Nadu, Tripura and West Bengal.

*Elsewhere* : Borneo, S. China, Java, Malaysia, New Ireland, Philippines, Solomon Island, Sri Lanka, Sumatra and Taiwan.

## Family ACRIDIDAE

***Hieroglyphus nigrorepletus* Bolivar**

1912. *Hieroglyphus nigrorepletus* Bolivar, *Boln. R. Soc. esp. Hist. nat.*, **23** : 56

1973. *Hieroglyphus nigrorepletus*: Mason, *Bull. Br. Mus. nat. Hist (Ent.)*, **28** (7) : 526.

*Material examined* : 1 ♂, 10.ix.1994, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : First and 3<sup>rd</sup> sulci of pronotum with broad black bands on lateral side of pronotum, 3<sup>rd</sup> sulcus joins the first laterally; 2 black bands connect all the sulci on dorsum, cerci simple, longer than supra-anal plate, apex oblique.

*Distribution* : India : Assam, Bihar, Delhi, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

*Elsewhere* : Bangladesh and Pakistan.

Order DICTYOPTERA

Suborder MANTODEA

***Ephestiasula intermedia* Werner**

1930. *Ephestiasula intermedia* Wener, *Proc. zool. Soc. Lond.*, : 689.

*Material examined* : 1 ex, 9.ix.1994, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Antennae not comb-like; fore tibiae with two rows of ventral spines; internal spines on fore femora arranged 1 long 1 short alternately; pronotum distinctly longer than broad; costal area of tegmina opaque, greenish-yellow and irregularly reticulated; posterior process of vertex blunt and short; external spines of fore tibiae numerous and closely beset.

*Distribution* : Jammu and Kashmir, Karnataka, Madhya Pradesh, Orissa, Rajasthan and Uttar Pradesh.

### SUMMARY

Thirteen species of Orthoptera and one species of Mantodea are studied here. Distributional range in India and abroad, taxonomic characters have also been given. Seven species of Orthoptera are newly recorded from Rajasthan.

### ACKNOWLEDGEMENTS

I am thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata for laboratory facilities. I am also grateful to the Officer-in-charge, Desert Regional Station, Zoological Survey of India, Jodhpur, for handing over the material to me for study. My thanks are also due to Dr. S.K. Mitra, Officer-in-charge (Retd.), Entomology Division, Zoological Survey of India, Kolkata for encouragement.

### REFERENCES

- Bhargava, R.N. 1990. First record of the genus *Arachnocephalus* Costa from India and description of the female *Loxoblemmus animae* Bhowmik (Insecta : Grylloidea). *Hexapoda*, 3(1 and 2) : 75-78.
- Bhargava, R.N. 1996. Grylloid fauna of the Thar Desert. In: *Faunal Diversity in Thar Desert: Gaps in Research*. (eds.) A. K. Ghosh, Q. H. Baqri and I. Prakash. Scientific Publishers, Jodhpur, India : 151-154.
- Bhowmik, H.K. 1967. *Gryllopsis rajasthanensis* Bhowmik. *Proc. Indian Sci. Cong. Assoc.*, Banaras, Part B : 491.
- Bhowmik, H.K. 1969. Studies on Indian Crickets (Orthoptera: Insecta) *Zool. Anz.*, Bd. 182, Helf ½ : 143-152.
- Bhowmik, H.K. 1971. Two new species of Grylloidea (Orthoptera) from India. *Oriental Ins.*, 5(4) : 503-506.

- Bhowmik, H.K. 1977. Studies on some Indian crickets with new distributional records of the subfamily Gryllinae (Gryllidae: Orthoptera). *Rec. zool. Surv. India*, **73** : 229-238.
- Bhowmik, H.K. 1985. Contributions to the gryllid fauna of the Western Himalaya (Orthoptera : Gryllidae) *Rec. zool. Surv. India, Occ. Paper No.*, **73** : 1-85.
- Blackith, R.E. 1992. The Tetrigidae (Insecta: Orthoptera) of South-East Asia. Catalogue of S. E. *Asian Tetrigidae* : 1-248 (Japaga Rockbottom, Ashford Co. Wicklow, Ireland).
- Chopard, L. 1969. *The Fauna of India, and the adjacent countries*, Orthoptera, Grylloidea, **2** : 1- 421.
- Kushwaha, K.S. and Bharadwaj, S.C. 1977. Forage and pasture insect pests of Rajasthan (ICRA, New Delhi) : 1-86.
- Mukherjee, T.K. Ghosh, A.K. and Hazra, A.K. 1995. Mantid Fauna of India (Insecta: Mantodea). *Oriental Ins.*, **29** : 185-358.
- Parihar, D.R. 1987. Grasshopper pest of grazing-land vegetation and their management in India desert. C.A.Z.R.I. Monograph No. **29** : 1-56.
- Parihar, D.R. 1996. Species richness of Orthoptera and Coleoptera in Thar Desert. In : *Faunal Diversity in the Thar Desert : Gaps in Research*. (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash. Scientific Publishers, Jodhpur : 155-166.
- Sharma, S.K. 1998. Aquatic biota of Rajasthan. In : *Reviving wetlands, Issues and challenges*. (ed.) S.K. Verma. Himanshu Publications, Udaipur : 75-94.
- Shishodia, M.S. 2004. Orthoptera. In : *Fauna of Desert National Park, Conservation Area Series*, **19** : 59-65. (Edited and Published by the Director, *Zool. Surv. India*, Kolkata).
- Shishodia, M.S. 2005. Orthoptera. In : *Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series*, **6** : 98-106. (Edited and Published by the Director, *Zool. Surv. India*, Kolkata).
- Tandon, S.K. and Shishodia, M.S. 1976. On a collection of Acridoidea (Orthoptera) from Rajasthan, India. *News. zool. Surv. India* **2** (1) : 7-11.
- Venkatesh, M.V. 1977. Some grasshoppers and locusts of Rajasthan. In: *Roonwal's Natural Resources of Rajasthan* (ed.) M.L. Roonwal. Jodhpur University Press, Jodhpur : 353-562.

## INSECTA : DERMAPTERA

G.K. SRIVASTAVA

Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053

### INTRODUCTION

The present paper deals with three species of Dermaptera, which were collected from Pichhola Lake, Udaipur. All the species are distributed world wide, except *Forcipula quadrispinosa* (Dohrn), which occurs in various parts of Oriental Region. The species recorded here commonly occur under stones, where a little moisture is available or on the edge of river and water bodies. The members of the genus *Forcipula* Bolivar, are known to swim for short distance in water.

### SYSTEMATIC ACCOUNT

Family ANISOLABIDIDAE  
Subfamily ANISOLABIDINAE

Genus *Euborellia* Burr

1909. *Borellia* Burr, *D. ent. Z.*, 325 (Type - *Anisolabis moesta* (Gene) in Serville, 1839 name pre-occupied by *Borellia* Rehn, 1906, Orthoptera).

1910. *Euborellia* Burr, *Proc. U.S. natn. Mus.*, 38 : 448 (Foot-note-new name for *Borellia* Burr, 1909).

#### *Euborellia annulipes* (Lucas)

1847. *Forficesila annulipes* (Lucas), *Annl. Soc. ent. Fr.* (2) 5 : 48 [Sex ?; Jardine des Plantes, Paris (Introduced)].

1997. *Euborellia annulipes*: Srivastava, *Fauna of Delhi, State Fauna Series*, 6 : 203. *Zool. Surv. India*.

*Material examined* : 1 ♀, 31.iii.1995, 1 nymph (Probably ♀), 29.iii.1995 coll. N.S. Rathore and S. Kumar.

*Distribution* : It has been reported from different parts of India. Worldwide but more commons in tropical parts.

Family LABIDURIDAE  
Subfamily LABIDURINAE

Genus *Labidura* Leach

1815. *Labidura* Leach, *Edin. Encyl.*, 9(1) : 48 (Type - *Forficula riparia* Pallas, 1773).

*Labidura riparia* (Pallas)

1773. *Forficula riparia* Pallas, *Reise Russ, Reichs*, 2 : 727 (Sex ?; Shores of Irtysh River, Western Siberia).

1863. *Labidura riparia*, Dohrn *Stettin ent. Ztg.*, 24 : 313.

1997. *Labidura riparia*: Srivastava, *Fauna of Delhi, State Fauna Series*, 6 : 204. *Zool. Surv. India*.

*Material examined* : 1 ♂, 2 ♀, 12.ix.1994, 2 ♂, 1 ♀ and 1 nymphs, 26.viii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : Worldwide. It is a species of arenicolous habit and occurs on riverbanks, beaches and other areas where there is plenty of sand and at least some moisture (Hincks, 1957).

Genus *Forcipula* Bolivar

1897. *Forcipula* Bolivar, *Ann. Soc. ent. Fr.*, 66 : 282 (type - *Labidura quadrispinosa* Dohrn, 1863-designated by Kirby, 1904).

1974. *Genitalata* Kapoor, *Zool. J. Linn. Soc.*, 55(1) : 83, figs. 14 (type - *Genitalata mahajani* Kapoor, 1974).

*Forcipula quadrispinosa* (Dohrn)

1863. *Labidura quadrispinosa* Dohrn, *Stettin ent. Ztg.*, 24 : 311 (Male; India: Tranquebar and Ceylon).

1974. *Genitalata mahajani* Kapoor, *Zool. J. Linn. Soc.*, 55(4) : 83, figs. 1-4, (Nymphs not male; India: Himachal Pradesh).

1986. *Forcipula quadrispinosa*: Srivastava, *Rec. zool. Surv. India, Occ. Pap. No.*, 89 : 28.

*Material examined* : 1 ♂, 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India: Assam, Bihar, Uttar Pradesh, Tamil Nadu and West Bengal (Kolkata and Darjeeling dist.).

*Elsewhere* : Bhutan, Indo-China, Java, Mauritius Myanmar, Nepal, Philippines Is., Renion, Sri Lanka and Thailand.

### SUMMARY

The paper reports two families of Dermaptera - Anisolabididae and Labiduridae represented by three species under three genera viz. *Euborellia annulipes* (Lucas), *Labidura riparia* (Pallas) and *Forcipula quadrispinosa* (Dohrn) from Pichhola Lake.

### ACKNOWLEDGEMENT

My thanks are due to the Director, Zoological Survey of India, Kolkata, for providing necessary facilities during the course of present work.

### REFERENCE

Hincks, W. D. 1957. The Earwigs of South Africa. *South African Animal Life*, 4 : 33-94.



## INSECTA : DICTYOPTERA : BLATTARIA

S.K. MANDAL AND M.S. SHISHODIA

Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053

### INTRODUCTION

The suborder Blattaria includes cockroaches. The head of these insects nearly or completely covered above by the shield-like structure called pronotum, the two ocelli usually represented by fenestrae, all the legs are similar to each other, coxae large and closely approximated; female with reduced ovipositor and male genitalia complex and asymmetrical.

Blattaria of Rajasthan is little known. There is no record available from wetland ecosystem fauna of Rajasthan. The present study is based on the material, collected by Drs. N. S. Rathore and S. Kumar of Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan. It deals with 4 species distributed under 3 families (Princis, 1960, 1963, 1964). All the species are new record to Rajasthan.

### SYSTEMATIC ACCOUNT

Order     DICTYOPTERA  
Suborder   BLATTARIA  
Family     DEROCALYMMIDAE

#### *Trichoblatta humbertiana* (Saussure)

1863. *Perisphaeria humbertiana* Saussure, *Mem. Soc. Geneve*, : 136.

1964. *Trichoblatta humbertiana*: Princis, *Orthopt. Catalog.*, Part 6 : 208.

*Material examined* : 2 ♂, 11.iii.1995 and 24.viii.1995. coll. N.S. Rathore and S. Kumar.

*Diagnostic characters* : Body arch-shaped, black with smooth surface; inter ocular space equal to first antennal socket; pronotum a little angular anteriorly, transverse posteriorly with bristle-like spines.

*Distribution* : India : Tamil Nadu.

*Elsewhere* : Sri Lanka.

Family PYCNOSSELIDAE

*Pycnoscelus surinamensis* (Linnaeus)

1758. *Blatta surinamensis* Linnaeus, *Syst. Naturae* (10th ed.) 1 : 424.

1964. *Pycnoscelus surinamensis*: Princis, *Orthopt. Catalog.*, Part 6 : 264.

*Material examined* : 5 ♀, 2 nymphs, 10.ix.1994, 27.viii.1995 and 29.iii.1996, coll. N. S. Rathore and S. Kumar.

*Diagnostic characters* : Body medium but robust; colour black-shining or blackish-brown; anterior and lateral edges of pronotum buff-coloured; tegmina translucent with buff-coloured margins.

This species generally exists in female sex, but occasionally parthenogenetic males occur in the culture of *Surinamensis*. Such males are non-functional when mated with females (Roth, 1967). Eight sternite of male rounded posteriorly, ninth completely hidden and bearing one style. Ocelli, in female, large; tegmina and hind wings extended up to the apex of abdomen and subgenital plate obtusely rounded at apex.

*Distribution* : Cosmopolitan.

Family BLATTELLIDAE

*Blattella germanica* (Linnaeus)

1767. *Blatta germanica* Linnaeus, *Syst. Naturae* 1 (2) : 688 (12th ed.).

1969. *Blattella germanica*: Princes, *Orthopt. Catalog.*, part 13 : 807.

*Material examined* : 1 ♂ 1 ♀, 6 nymphs, 25, 28.viii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnostic Characters* : Body small and narrow; two dark-brown longitudinal stripes separated by a yellowish stripe on the disc of pronotum; antero-ventral margin of front femur armed with long spines on basal half, followed by small spines with three longer, unequal spines at apex; arolae small.

*Distribution* : Cosmopolitan.

*Symploce biligata* (Walker)

1866. *Ischnoptera biligata* Walker, *Cat. Blatt. Brit. Mus.*, : 123.

1969. *Symploce biligata*: Princis, *Orthopt. Catalog.*, Part 13 : 886.

*Material examined* : 4 ♂, 1 ♀, 11 & 29-30.iii.1995, coll. N.S. Rathore and S. Kumar.

*Diagnostic Characters* : Body size medium; vertex exposed; tegmina exceeding the abdomen, the plical notch scarcely indicated; radial vein bifurcated beyond the middle; subgenital plate large, with short, cylindrical styles inserted near the apex. Male with distinct brown band on fore head and with two big round tubercles at the base on 7th tergite.

*Distribution* : India : Delhi, Meghalaya, Orissa, Sikkim and West Bengal.

*Elsewhere* : Sri Lanka.

### SUMMARY

This paper deals with 4 species distributed under 4 genera and 3 families. Each species is provided with the distribution. All the species are new records and reported for the first time from Rajasthan.

### ACKNOWLEDGEMENTS

We are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata, for laboratory facilities and the Officer-in-charge, Desert Regional Station, Zoological Survey of India, Jodhpur, who has kindly handed over the material for study. We are also grateful to Dr. S.K. Mitra, Scientist-F (Retd.) and Officer-in-charge, Entomology Division for kind help.

### REFERENCES

- Princis, K. 1960. Zur. Systematic der Blatterien. *Eos. Madr.*, 36 : 427-449.
- Princis, K. 1963. Blattariae : Sub family Derocalymmidae. In : M. Beier (ed.), *Orthopterorum Catalogus*, Part 4 : 75-172.
- Princis, K. 1964. Blattariae, Suborder Blaberoidea, family: Pycnoscalidae, In : M. Beier (ed.), *Orthopterorum Catalogus*, Part 6 : 174-281.
- Roth, L.M. 1967. Cockroaches from the Krakatan Islands (Dictyoptera: Blattaria). *Mem. Mus. Victoria*, 50 : 357-378.



## INSECTA : ISOPTERA

N.S. RATHORE AND N. TAK

Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan

### INTRODUCTION

Termites form an important group of insects, the order Isoptera. They cause extensive damage to agriculture crops, vegetables, forest trees etc. The annual losses so caused amount to millions of rupees.

To get the information regarding termite fauna extensive surveys and intensive collection of termites was made around Pichhola Lake Udaipur, during years 1994 to 1997. The present communication is based on the study of this collection. Earlier Kushwaha (1960 and 1961), Roonwal and Bose (1964) and Roonwal and Verma (1977) reported eight species from Udaipur district viz. *Microcerotermes palestinensis* Spaeth, *Microcerotermes raja* Roonwal & Bose, *Odontotermes bellahunisensis* Holmgren & Holmgren, *Odontotermes guptai* Roonwal & Bose, *Odontotermes kushwahai* Roonwal & Bose, *Odontotermes obesus* (Rambür), *Microtermes obesi* Holmgren and *Trinervitermes biformis* (Wasmann).

Recent studies further added seven more species to already known termite fauna from the Udaipur district, out of these two are recorded for the first time from Rajasthan State and five from Pichhola Lake Udaipur. Altogether ten species belonging to two families were collected during the surveys which are being reported here.

The detailed information in respect of termite fauna from Rajasthan was dealt in excellent manner by Kushwaha (1960 and 1961), Roonwal and Bose (1964 and 1969), Roonwal (1977), Roonwal and Verma (1977), Roonwal and Chhotani (1989), Chhotani (1997) and Rathore and Bhattacharya (2004 a, b).

### SYSTEMATIC ACCOUNT

Family RHINOTERMITIDAE  
Subfamily HETEROTERMITINAE

Genus *Heterotermes* Frogatt*Heterotermes indicola* (Wasmann)

1902. *Leucotermes indicola* Wasmann, *Zool. Jahrb. Abs. Systs., Jena*, 17(1) : 118-119. Soldier and Worker. Type-locality : Bombay, India

1949. *Heterotermes indicola* Snyder, *Smiths. misc. coll.*, 112 : 68.

1979. *Heterotermes indicola* Thakur and Sen-Sharma, *Indian For. Rec.*, 13(2) : 10-15.

*Material examined* : Many S and W, 9.ix.1994, 8S and 40W, 12.ix.1994, 4S and 10W, 3.iv.1996, All castes collected from shoreline habitat, coll. N.S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : Distributed all over northern India up to an altitude of 1800 m and above 20° N Lat., Gujarat (Kutch region), Rajasthan.

*Remarks* : First time reported from Udaipur district. It is wood-inhabiting termite and causes serious damage to wooden material as well as number of tree species in Rajasthan. The species collected from Date palm tree growing around Pichhola Lake.

*Heterotermes gertrudae* Roonwal

1953. *Heterotermes gertrudae*, Roonwal, *Indian J. Ent.*, 15(2), 115-118., S, W. Holotype : S, in AMNH. Type-locality : Almora (Uttar Pradesh, India).

1976. *Heterotermes gertrudae*, Roonwal and Verma, *Rec. zool. Surv. India*, 69 : 241-247.

*Material examined* : 5 S and 30 W, 9.ix.1994, all caste collected from shoreline habitat, coll. N.S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : India : Northwest Himalayas : Almora and Rishikesh (Uttar Pradesh), Melha (Himachal Pradesh) and Pichhola Lake area Udaipur (Rajasthan).

*Remarks* : This species is recorded for the first time from Rajasthan and found damaging Date palm tree around Pichhola Lake area.

## Subfamily COPTOTERMITINAE

Genus *Coptotermes* Wasmann*Coptotermes heimi* (Wasmann)

1902. *Arrhinotermes heimi*, Wasmann, *Zool. Jahrb. Abt. Syst.*, Jena, 17 (1), 104, Imago, Type-locality : India : Maharashtra : Wallon (Ahmadnagar).

1904. *Coptotermes heimi*, Desneux, *Genera Insect, Isoptera, Fasc. 25* : 34.

1949. *Coptotermes heimi* Snyder, *Smiths. misc coll.* **112** : 79.

1962. *Coptotermes heimi* Roonwal and Chhotani, Monogr, Indian species of Termite Genus *Coptotermes*, New Delhi (ICAR., *Entomol. Monogr.* No. 2). 38-57.

*Material examined* : 4 S and 15 W, 9.ix.1994, from Date palm tree, 18 S and 5 W, 9.ix.1994, from *Ficus* tree trunk. All caste collected from shoreline habitat, coll N.S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : Widely distributed almost all over India.

*Elsewhere* : Bangladesh, Bhutan, Nepal, Pakistan and recently introduced to Oman.

*Remarks* : First time reported from Udaipur district. It is subterranean and a very common termite, which reaches dry wood above ground. It is known to attack the dead wood of a large number of trees. Around Pichhola Lake it was collected from Date palm and *Ficus* tree trunk damaging the 2/3 of its trunk.

Family TERMITIDAE

Sub family AMITERMITINAE Kemner

Genus *Amitermes* Silvestri

*Amitermes belli* (Desneux).

1906. *Termes belli*, Desneux, *Ann. Soc. entomol. Belg.*, Brussels, **49** (12) : 352-354, Imago, soldier and worker. Type locality: Pakistan, Karachi (Sind).

1912. *Hemitermes (Hemitermes) belli* (Desneux) Holmgren, K., *Svenska Vetensk. Acad. Handl.*, **48** (4) : 93.

1949. *Amitermes belli* Snyder; *Smiths misc. coll.*, **112** : 114

1964. *Amitermes belli* Roonwal and Bose. *Zoologica*, **40** (113) : 19-21.

1972. *Amitermes belli* Chaudhary, Ahmad, Malik, Akhtar and Arshad. Final Techn. Rep., P.L- 480 Project (1967-1972) : 55.

*Material examined* : 10 S and 55 W, 9.ix.1994, From Date palm tree trunk, 6 S and 18 W, 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : India : Rajasthan, Delhi, Madhya Pradesh and Gujarat.

*Elsewhere* : Pakistan : Sind, Punjab and Baluchistan.

*Remarks* : This species is reported for the first time from Udaipur district. The species was collected for the first time from Date palm tree around Pichhola Lake.

Genus *Microcerotermes* Silvestri*Microcerotermes heimi* Wasmann

1902. *Microcerotermes heimi* Wasmann. *Zool. Jahrb. Abt. Syst., Jena*, **17** (1) : 120-121. Soldier. Type-locality: Vorder Indian (Bombay, vide Holmgren; 1913 : 251).

1949. *Microcerotermes heimi* Snyder, *Smith. misc. coll.*, **112** : 140.

1967. *Microcerotermes heimi* Prashad, Thapa and Sen-Sarma, *Indian For. Bull. No.*, **246** : 44-46.

*Material examined* : 3 S and 15 W, 10.ix.1994, 1 S and 12 W, 3.iv.1996, all caste collected from shoreline habitat, coll. N. S. Rathore and S. Kumar.

*Caste Known* : Soldier (S), Worker (W) from Pichhola Lake area.

*Distribution* : India : Assam, Gujarat, Karnataka, Maharashtra and Rajasthan.

*Elsewhere* : Sri Lanka.

*Remarks* : It is recorded for the first time from Pichhola Lake area as well as from Rajasthan state.

*Microcerotermes palestinensis* Spaeth

1964. *Microcerotermes palestinensis*, Spaeth, *Israel J. Zool.*, **13** : 30-32. Imago, Soldier and Worker. Type locality : Israel: Negev location 50, Wadi Abyad (Nahal Lavan).

1974. *Microcerotermes palestinensis*: Roonwal, *J. Zool. Soc. India*, **24** (2) : 193-194.

1977. *Microcerotermes palestinensis* Roonwal and Verma, *Rec. zool. Surv. India*, **72** : 439-440.

*Material examined* : 2 S and 30 W, 10.ix.1994, all caste collected from shoreline habitat, coll. N. S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : India : Gujarat and Rajasthan. Elsewhere: West Asia (Israel).

*Remarks* : The economic importance of the species in Indian context is not known.

*Microcerotermes tenuignathus* Holmgren

1913. *Microcerotermes tenuignathus* Holmgren, *J.B.N.H.S., Bombay*, **22** (1) : 116-117. Soldier and Worker. Type locality : Vadtal (Gujarat : India).

1949. *Microcerotermes tenuignathus* Snyder, *Smiths. misc. coll.*, **112** : 147.

1967. *Microcerotermes tenuignathus* Prashad, Thapa and Sen-Sarma, *Indian For. Bull. No.* **246** : 52-55.

1977. *Microcerotermes tenuignathus* Roonwal and Verma, *Rec. zool. Surv. India*, **72** : 442.

*Material examined* : 3 S and 22 W, 12.ix.1994, from date palm tree trunk, 2 S and 29 W, 28.viii.1995, all caste collected from shoreline habitat, coll. N. S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : India : Gujarat, Maharashtra and Rajasthan.

*Elsewhere* : Baluchistan, N.W.F.P., Pakistan, Punjab and Sind.

*Remarks* : First time reported from Udaipur district. The species is a versatile one and occurs in dry as well as wet areas.

### Subfamily MACROTERMITINAE

#### Genus *Odontotermes* Holmgren

#### *Odontotermes gurdaspurensis* Holmgren and Holmgren

1917. *Odontotermes (Cyclotermes) obesus f. gurdaspurensis*, Holmgren and Holmgren. *Mem. Dept. Agric. (Ent.)*, 5 (3) : 149-150. Imago, Soldier and Worker. Type locality : India : Punjab : Gurdaspur.

1949. *Odontotermes (Cyclotermes) obesus f. gurdaspurensis*, Snyder, *Smiths misc. coll.*, 112 : 235.

1955. *Odontotermes (Cyclotermes) obesus f. gurdaspurensis*, Ahmad, *Biologia*, Lahore, 1 : 222-224.

1981. *Odontotermes (Cyclotermes) obesus f. gurdaspurensis*, Thakur: *India For. Rec. (N. S.) Ent.*, 14 (2) : 59-63.

*Material examined* : 7S and 18W, 9.iii.1995, 6S and 11W, 1.iv.1997. All caste collected from shoreline habitat, coll. N. S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : Widely distributed in India : Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Madhya Pradesh, West Bengal, Rajasthan, Maharashtra and Gujarat.

*Elsewhere* : Pakistan : Baluchistan, Islamabad, Jhelum, Kohat, Lahore, Loralai, N.W.F.P., Peshawar and Rawalpindi.

*Remarks* : First time reported from Udaipur district. It is a well known mound building termite species and has capability to attack wooden materials.

#### *Odontotermes obesus* (Rambur)

1842. *Termes obesus* Rambur, *Hist. natur. Insects Neuroptera*, Paris: 304 Imago. Type locality: India: Bombay.

1965. *Odontotermes obesus* Krishna, *Am. Mus. Novit*, No. 2210 : 24-25.

1970. *Odontotermes obesus*, Roonwal, In : *Biology of Termites* (Eds. Krishna and Weesner) Vol. 2 : 364-365.

1981. *Odontotermes obesus*. Thakur, *Indian For. Rec.* (N. S.) Ent., **14** (2) : 100-107.

*Material examined* : 20 S and 15 W, 12.ix.1994, 12S and 33 W, 27.viii.1995. All caste collected from shoreline habitat, coll. N.S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : Occurring all over India,

*Elsewhere* : Myanmar, Bangladesh and Pakistan.

*Remarks* : Most common mound building termite species.

#### Genus *Microtermes* Wasmann.

##### *Microtermes obesi* Holmgren

(Synonyms : *M. anandi* Holmgren, *M. anandi f. curvignathus* Holmgren)

1912. *Microtermes obesi* Holmgren, *J. Bombay nat. Hist. Soc.*, **21** (3) : 787-788. Imago. Type locality : India : Maharashtra : Khandala (near Bombay).

1949. *Microtermes obesi* Snyder, *Smiths. misc. coll.*, **112** : 252.

1964. *Microtermes obesi* Chatterjee and Thakur, *Ind. For. Rec.* **10** (11) : 234-239.

*Material examined* : 4 S and 20 W, 9.ix.1994. From Ficus tree trunk, coll. N. S. Rathore and S. Kumar.

*Caste Known* : Soldier (S) and Worker (W) from Pichhola Lake area.

*Distribution* : This is one of the most common and widely distributed species of genus *Microtermes* and recorded from all over India.

*Elsewhere* : Bangladesh, Bhutan, Burma, Kampuchea, Pakistan, Thailand, Sri Lanka and Vietnam.

*Remarks* : Most common species of the genus causing heavy damage to agricultural crops, fencing, fallen stems and twigs (litter).

### SUMMARY

In total ten species of termites belonging to two families have been reported from Pichhola Lake shoreline area. Seven species are reported for the first time from the Pichhola Lake. Two species viz. *Microcerotermes heimi* Wasmann and *Heterotermes gertrudae* Roonwal are new record from Rajasthan (Pichhola Lake) and five species viz. *Heterotermes indicola* (Wasmann), *Coptotermes heimi* (Wasmann), *Amitermes belli* (Desneux), *Microcerotermes tenuignathus* Holmgren and *Odontotermes gurdaspurensis* Holmgren and Holmgren are new record from Udaipur district.

**ACKNOWLEDGEMENTS**

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Z.S.I. Kolkata and the Officer-in-charge, D.R.S., Z.S.I., Jodhpur for providing facilities and opportunity to survey this wetland of Udaipur.

**REFERENCES**

- Chhotani, O.B. 1977. Fauna of India-Isoptera (Termites Vol.II. XX + 801 pp. (Publ. *Zool. Surv. India*).
- Kushwaha, K.S. 1960. A note on infestation of termites (Insecta: Isoptera) around Udaipur (Rajasthan). *Sci. & Cul.*, **26**(1) : 39-40.
- Kushwaha, K.S. 1961. A note on termites (Insecta: Isoptera) infesting sugarcane crop in Rajasthan. *Sci. & Cul.*, **30** : 229-230.
- Rathore, N.S. and Bhattacharya, A.K. 2004 a. Termite (Insecta : Isoptera) fauna of Gujarat and Rajasthan, present state of knowledge. *Rec. zool. Surv. India, Occ. Paper No.*, **223** : 1-77 + 8 pls.
- Rathore, N.S. and Bhattacharya, A.K. 2004 b. An updated checklist of termites (Isoptera) of Rajasthan. *In Advancement in Insect Biodiversity* (Ed. R.K. Gupta) : 225-236. (Published by Agrobios, India, Jodhpur).
- Roonwal, M.L. 1977. Rajasthan termites (Insecta; Isoptera). In: National Resources of Rajasthan, Vol. I (Ed. M.L. Roonwal), University of Jodhpur, Jodhpur : 373-379.
- Roonwal, M.L. and Bose, G. 1964. Termite fauna of Rajasthan, India. *Zoologia*, **40**(3) : (Heft: 113); vi + 58 pp. + 5 pls.
- Roonwal, M.L. and Bose, G. 1969. Fauna of Rajasthan, India, Part 4. A checklist of Rajasthan termite (Insecta: Isoptera). *Rec. zool. Surv. India*, **61**(3 & 4) : 437-450.
- Roonwal, M.L. and Chhotani, O.B. 1989. Fauna of India : Isoptera (Termites). Vol. I. viii + 672 + i pp. (Publ. Director, *Zool. Surv. India* Calcutta).
- Roonwal, M.L. and Verma, S.C. 1977. Resurvey of the termite fauna of Rajasthan, India and its Zoogeography. *Rec. zool. Surv. India*, **72** : 425-480.



## **INSECTA : DIPTERA : CHIRONOMIDAE**

**S. KUMAR**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### **INTRODUCTION**

Diptera is one of the four largest order of the class Insecta. It contains many members who's larval stage have become adapted to fresh water and great many more occupies semi-aquatic habitats. The larvae of some of the families of Diptera form the major constituent of any aquatic ecosystem. Chironomidae is a family of mostly freshwater amphibiotic dipterans, inhabiting almost all the ecological niches from high altitude glacial torrents to shallow eutrophic inland lakes. The larvae are planktonic in nature and also form the benthic component of the lakebed where as the adult forms the swarms in and around the lake as also gyrate on the surface of the water. The larvae of Chironomidae are called "blood worms" and the members of the family are known as "Gnats" or "non-biting midges" The swarming adults can be seen on the margins of the lake and also hiding and resting on the vegetation. They abundantly thrive in lake waters and also form an important food of fishes.

During the course of different surveys conducted from 1994-1997 collections were made from different points in the lake water. The immature stages and adults were collected, preserved in the field, sorted out in the laboratory, labelled and processed for study. For identification of Chironomidae larvae, slide mounts were prepared using the rapid Polyvinyl-lactophenol technique for mounting mouth-parts (Beck, 1976) and key for generic characters (Alfred, 1972).

Earlier, four genera of Chironomidae were reported from Rajasthan (Singh, 1988 and Kumar, 2005). Chironomid larvae are chiefly herbivorous and feed on algae, higher aquatic plants and organic detritus. Their locomotion consists of a series of creeping or looping movements, although some species are active swimmers. They mostly construct fragile tubes composed of algae, fine silt or sand grains cemented together with a salivary secretion.

The increasing urbanization of areas surrounding Pichhola Lake results in eutrophication of water making possible increased production of Chironomid midges. The even greater load of nutrient materials which are added to the lake waters from domestic sewage, industry and crop fertilizers result in a situation ideally suited for the production of midges. They emerge in such large numbers so as to produce "pest swarms" This phenomenon is also reported by Sublette and Sublette (1973). The adult Chironomidae appear on the wings just after emergence and exhibit specific swarming behaviour in the air. Sometimes they swarm in such large numbers that they may effectively discourage the use of such areas for recreation and summer homes.

### SYSTEMATIC ACCOUNT

Class	INSECTA
Order	DIPTERA
Family	CHIRONOMIDAE
Subfamily	CHIRONOMINAE
Tribe	<b>Chironomini</b>

Genus *Dicrotendipes* Kieffer 1913

#### *Dicrotendipes* sp.

1913. *Dicrotendipes* Kieffer *Voy. Alluoud Teannel Afr. Or. Ins. Dipt.*, 1 : 23; 1922, *Ann. Soc. Ent. France*, 91 : 63; 1925, *Bull. Soc. R. Ent. Egypte*, 1924 : 297.

1955. *Dicrotendipes* Freeman, *Explor. Parc. Nat. Albert. Misc. de. Witte*, 83 : 20.

*Material examined* : 4 exs. (larvae) on slide, 12.ix.1994, coll. S. Kumar.

*Distribution* : Kerala and Uttar Pradesh.

*Remarks* : It is a new record from Rajasthan.

Genus *Chironomus* Meigen 1803

#### *Chironomus* sp.

1800. *Tendipes*, Meigen, *Nouv. Class. Mouches* : 17.

1803. *Chironomus* Meigen, *Illigeris Mag.*, 2 : 260.

*Material examined* : 3 exs. (larvae) on slide, 12.ix.1994, coll. S. Kumar.

*Distribution* : Cosmopolitan.

*Remarks* : Many species in this genus are bio-indicators of water quality.

Genus *Endochironomus* Kieffer, 1918.

*Endochironomus* sp.

1918. *Endochironomus* Kieffer *Ann. Mus. Nat. Hung.*, 16 : 69; 1921. *Ann. Soc. Sci. Brux.* 40 : 273.

1923. *Endochironomus* Lenz. *Verch. Int. ver. Limnol. Kiel*, 1922 : 158.

1955. *Endochironomus* Freeman, *Ann. Mus. Congo Tervuren*, 36 : 288.

*Material examined* : 2 exs., (larvae) on slide, 2.iv.1996. coll. S. Kumar.

*Distribution* : Rajasthan.

*Remarks* : It is recorded for the first time from Udaipur.

Genus *Polypedium* Kieffer 1913

*Polypedium angustiforceps* Kieffer

1913. *Polypedium angustiforceps* Kieffer *Rec. Indian Mus.*, 9 : 148.

*Material examined* : 3 ♀, 2 ♂, on slide, 18.xi.1995 and 2.iv.1996, coll. S. Kumar.

*Distribution* : Uttar Pradesh, West Bengal.

*Remarks* : It is new record from Rajasthan.

Tribe **Tanytarsini**

Genus *Tanytarsus* van der Wulp 1824

*Tanytarsus agraensis* Singh and Kulshrestha.

1975. *Tanytarsus agraensis* Singh and Kulshrestha. *Oriental Ins.* 9 (4) : 421.

*Material examined* : 2 ♂, 2 ♀ on slide, 18.xi.1995, coll. S. Kumar.

*Distribution* : Uttar Pradesh.

*Remarks* : It is recorded for the first time from Rajasthan.

Subfamily **ORTHOCLADIINAE**

Genus *Cricotopus* van der Wulp 1874

*Cricotopus pentazonus* (Kieffer)

1911. *Cricotopus pentazonus* Kieffer *Rec. Indian Mus.* 6 : 345.

*Material examined* : 4 ♂, 1 ♀ on slide, 12.ix.1994, coll. S. Kumar.

*Distribution* : India : Rajasthan and Uttar Pradesh. Elsewhere: Nepal.

*Remarks* : It is a new distributional record from Udaipur, Rajasthan.

### SUMMARY

The present paper reports six genera under two subfamilies : Chironominae and Orthoclaadiinae. Five species are reported for the first time from Pichhola Lake, out of which three are new records from Rajasthan. The species belonging to Chironominae and Orthoclaadiinae are significant components of the fish food assemblage. Eutrophication of Pichhola Lake is resulting into production of chironomid 'pest swarms' which may effectively discourage the use of such areas for recreation and summer homes.

### ACKNOWLEDGEMENTS

The author is thankful to the Director, Zoological Survey of India, Kolkata and the Officer-in-charge, Desert Regional Station, ZSI, Jodhpur for providing facilities to carry out this work.

### REFERENCES

- Alfred, J.R.B. 1972. Chironomidae : In : A guide to the identification of freshwater Organisms. Ed. R. George Michael, *Suppl. I. Jour. Madurai University*.
- Beck, William M. Jr. 1976. Biology of the larval chironomids. State of Florida Dept. Env. Regulation. *Technical Series* Vol. 2. No. 1.
- Kumar, Sanjeev, 2005. Chironomidae. In : *Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series*, 6 : 113-118. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Singh, Santokh, 1988. Investigation on the taxonomy, cytotaxonomy and biology of Chironomidae (Diptera) from Indian faunal limits. Final progress report of DST research Project : 1-73, pl. I-XVIII.
- Sublette, James E. and Sublette, Mary F. 1973. Family Chironomidae In: A Catalog of Diptera of the Oriental Region. Suborder: Nematocera (compiled & ed.) M.D. Delfinado and D.E. Hardy. The University Press of Hawaii, Honolulu. Vol. 1 : 389-422.

## **INSECTA : COLEOPTERA**

**P. MUKHOPADHYAY, S.K. CHAKRABORTY, D.N. BISWAS, S.K. HALDER,  
S.K. GHOSH, P.CHAKRABORTY AND S. SENGUPTA**

*Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053*

### **INTRODUCTION**

India is very rich in wetland resources and exhibit significant ecological diversity because of variability in climatic conditions and the changing topography. Of the total geographical area (3,42,239-sq. km.) of Rajasthan, the total wetland area is 1,14,244 ha. of which natural wetlands area is about 14,027 ha. and manmade wetlands is about 1,00,217 ha.

Pichhola Lake is the oldest manmade wetland in Udaipur City of Rajasthan State and lies between 24°35' latitude (N) and 73°49' longitude (E) having an area of about 1,480 ha. belonging to freshwater ecological category.

The order Coleoptera is by far the largest order of Insecta in the animal kingdom. The members of this order are commonly known as beetles and it includes nearly a quarter of a million known species, which are about 40% of the insect fauna of the world. The habit of different types of beetles are so varied or diversified that they can invade in every main type of environment suitable for their existence (Fabricius, 1781; Knisch, 1924). They may be herbivorous, putrivorous and carnivorous and many of them are extremely injurious to our agricultural crops, horticultural and forest trees. Some of them are serious pests of stored grains and their products.

Earlier information on coleopteran insects from wetlands of Rajasthan is very little. Though Vazirani (1977) has recorded a number of aquatic species of coleoptera from Rajasthan. Saha (1979) has also recorded a number of blister beetles from Rajasthan. Mukhopadhyay, *et al.* (2005) and Chatterjee and Mukhopadhyay (2005) worked the coleoptera associated with Sambhar wetland, Rajasthan.

The present account of coleopteran fauna of Pichhola Lake of Rajasthan is based on the material collected by the Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan during 1994 to 1997. Altogether 23 species belonging to 18 genera under 7 families have been studied with the discovery of one species new to science and several new records.

Information regarding diversity, habitat, economic importance and general characteristics of the families has been given. Collection data on the materials studied have been incorporated. Distributional data of the species has been given from the published records as well as actual study of the specimens. First reference and recent valid name of each genus and species have been given.

## SYSTEMATIC ACCOUNT

### Family CARABIDAE

This is one of the largest families of the order Coleoptera. The members of the family are almost terrestrial being found under stone or bark, in moss, rotten wood etc. They are carnivorous and predaceous and few of them also eat the young seeds and growing corn [Borelli (1809), Andrews (1930), Saha and Sengupta (1979a & b)].

### Genus *Omphra* Reiche, 1842

1842. *Omphra* Reiche, A. F. : 330.

1930. *Omphra* Andrews, *Cat. Ind. Insects*, Part 18, Carabidae, : 1-388.

### *Omphra rufipes* Klug

1834. *Omphra rufipes* Klug., *Jahrb. Ins.*, : 72.

*Material examined* : 3 ex., 9.x.1994, coll. N. S. Rathore and S. Kumar.

*Distribution* : India : Andhra Pradesh, Rajasthan.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

### Genus *Pheropsophus* Solier, 1883

1833. *Pheropsophus* Solier, *Ann. Mag. nat. Hist.*, : 461.

### *Pheropsophus catoirei* (Dejean)

1825. *Pheropsophus catoirei* Dejean, *Species General Coleoptera* : 1.

1875. *Pheropsophus catoirei* Putz, *Comot. Soc. Ent. Belgious* : 45.

1901. *Pheropsophus catoirei* Arrow, *Trans. Ent. Soc. London* : 202.

*Material examined* : 2 exs., 26.viii.1995, 2 exs., 31.iii.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Throughout, westward to Kashmir, Rajasthan.

*Elsewhere* : Myanmar, Sri Lanka and Pakistan.

Genus *Chlaenius* Dejean, 1826

1826. *Chlaenius* Dejean, *Species Generaldes Coleopteres*, 2 : 297.

*Chlaenius (Chlaenites) circumdatus* Brulle

1835. *Chlaenius circumdatus* Brulle, *Silberm Rev. ent.*, 3 : 283.

1975. *Chlaenius (Chlaenites) circumdatus* Brulle: Saha and Sengupta, *Annales dela Societe suisse de Zoologie, Mus.d' Hist. Nat. Geneva*, 86 (2) : 419-425.

*Material examined* : 2 ex., 31.iii.1997, coll. N. S. Rathore and S. Kumar.

*Distribution* : India : Kerala, Rajasthan.

*Elsewhere* : Sri Lanka, Myanmar, Malay Peninsula, Malay Archipelago, Laos, Cambodia, Vietnam, China, Formosa, Japan and Korea.

Family PAUSSIDAE

The habits of the members belong to this family are very interesting. They are mainly myrmecophilous and have the power of secreting a substance that is pleasing or nourishing to the ants with which they live. Shape of antennae is the characteristic feature of the family [Fowler (1912), Saha *et al.*, (1995)].

Subfamily PAUSSINAE

Genus *Paussus* Linne., 1775

1775. *Paussus* Linne, *Bigae Insect.*, : 7.

1912. *Paussus* Fowler, *Fauna of British India including Ceylon and Burma*, Coleoptera, Genel. Intro. and Cicindelidae and Paussidae : 469-500.

*Paussus desneuxi* Fowler

1912. *Paussus desneuxi* Fowler, *Fauna of British India including Ceylon and Burma*, Coleoptera, Genel. Intro. and Cicindelidae and Paussidae : 475-476.

*Material examined* : 1 ex., 9.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from India (Rajasthan).

## Family DYTISCIDAE

The members of this family are commonly known as 'predaceous diving beetles'. They are very active swimmers and inhabit in both fresh and brackish water. They also serve as food for carnivorous or omnivorous fishes. So far 25 species under 13 genera belonging to 5 subfamilies viz. Noterinae, Laccophilinae, Hydroporinae, Colymbetinae and Dytiscinae are recorded from Rajasthan [Guignot (1954), Vazirani (1968, 1977)]. In the present study one genus is recorded from Pichhola Lake, Rajasthan.

Genus *Hyphoporus* Sharp, 1882

1882. *Hyphoporus* Sharp, *Sci. Trans. R. Dublin Soc.*, 2 : 390, 859.

1977. *Hyphoporus* Vazirani, *Cat. Orient. Dytiscidae* : 44.

*Hyphoporus* sp.

*Material examined* : 15 exs., 12.ix.1994, coll. N.S. Rathore and S. Kumar.

## Family HYDROPHILIDAE

The family Hydrophilidae belongs to the superfamily Hydrophiloidea of the suborder Polyphaga: Coleoptera and are commonly known as 'water scavenger beetle'. Majority of them are truly aquatic and few of them are terrestrial and found in moist places. This insect varies from small to large in size and can be easily distinguished by its maxillary palpi, which may be mistaken as antennae (d'orchymont, 1928).

## Subfamily HYDROPHILINAE

## Tribe Hydrobiini

Genus *Paracymus* Thomson, 1867.

1867. *Paracymus* Thomson, *Skand. Col.*, 9 : 119, 120.

1924. *Paracymus* Thomson, *Col. Cat.* 14 (79) : 164-168.

*Paracymus evanescens* (Sharp)

1890. *Hydrobius evanescens* Sharp. *Trans. Ent. Soc. London.* : 349.

1924. *Paracymus evanescens*, Knisch. *Col. Cat.* 14 (79) : 166.

*Material examined* : 1 ex., 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Bihar, Rajasthan and West Bengal.

*Elsewhere* : Indonesia, Philippines, Sri Lanka and Tonkin.

*Remarks* : This species is recorded for the first time from Rajasthan.

Genus *Helochares* Mulsant, 1844

1844. *Helochares* Mulsant, *Hist. Nat. Col. Fr. Palp.*, : 197.

*Helochares crenatus* Regimbart

1903. *Helochares crenatus* Regimbart, *Ann. Soc. ent. Fr.*, 72 : 54.

*Material examined* : 1 ex., 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India: West Bengal, Bihar, Rajasthan, Pondicherry.

*Elsewhere* : Indonesia, Philippines, F.M.S. Indo-China, Cochin-China, Cambodia, Tonkin, Sunda Is.

*Remarks* : This species is recorded for the first time from Rajasthan.

*Helochares densus* Sharp

1890. *Helochares densus* Sharp, *Trans. Ent. Soc. London* : 353.

*Material examined* : 1 ex., 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India: Rajasthan.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from India: Rajasthan.

Genus *Enochrus* Thomson, 1859

1859. *Enochrus* Thomson, *Skand. Col.* 1 : 18.

1924. *Enochrus* Thomson, *Col. Cat.*, 14 (79) : 200-219.

*Enochrus escuriens* (Walker)

1858. *Philhydrus escuriens* Walker, *Ann. Mag. Nat. Hist.*, (3) 2 : 209.

1924. *Enochrus escuriens*, Knisch, *Col. Cat.*, 14 (79) : 209.

*Material examined* : 3 exs., 12.ix.1994, coll. N.S. Rathore and S. Kumar

*Distribution* : India : Nicobar Islands, Rajasthan and West Bengal.

*Elsewhere* : Annam, Australia, Cochin-China, F.M.S. Siam, Indonesia, Indo-China, Philippines, Queensland, Sri Lanka, Sunda Island, Tonkin and Vietnam.

*Remarks* : This species is recorded for the first time from Rajasthan.

Tribe **Amphiopini**Genus ***Amphiops*** Erichson, 1843

1843. *Amphiops* Erichson, *Arch. F. Naturg.*, 9 (1) : 229.

1924. *Amphiops* Erichson, *Col. Cat.*, 14 (79) : 259-260.

***Amphiops pedestris*** Sharp

1890. *Amphiops pedestris* Sharp, *Trans. Ent. Soc. Lond.*, : 354.

*Material examined* : 2 ex., 12.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India: Bihar, Pondicherry, Rajasthan, Tamil Nadu and West Bengal.

*Elsewhere* : China, Indo-China, Indonesia and Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

## Family HISTERIDAE

The family Histeridae belongs to the superfamily Histeroidea of the order Coleoptera. This family is well represented in the Indian Subcontinent. Members of this family are very small to medium in size, round, oval, flat or elongated in shape, generally black and shining, sometime with metallic luster with hard exoskeleton. They are predacious in habit both in larval and adult form. They occur in variety of habitats like in soil, dung of various animals, termite and ant nests and under bark. Members of the subfamily Saprininae are carrion feeders. Some of the members are predators on the under bark fauna.

Till now about 175 species under 34 genera are known from India in comparison to about 200 genera and 3000 species all over the world. [Erichson (1834), Bickhardt (1910 and 1913), Chakraborty and Biswas (1995)]. So far no species are recorded from Rajasthan.

## Subfamily SAPRININAE

Genus ***Saprinus*** Erichson, 1834

1834. *Saprinus* Erichson, in *Klug. Jahrb. Ins.*, 1 : 172.

***Saprinus speciosus*** Erichson

1834. *Saprinus speciosus* Erichson, in *Klug. Jahrb. Ins.*, 1 : 179.

1910. *Saprinus speciosus* Bickhardt, *Copt. Cat.*, 8 (24) : 100.

*Material examined* : 3 exs., 10.ix.1994, coll. N. S. Rathore and S. Kumar.

*Distribution* : India : Pondicherry, Rajasthan and West Bengal.

*Elsewhere* : Australia, China and Japan.

*Remarks* : This species is recorded for the first time from Rajasthan.

Subfamily HISTERINAE

Tribe Histerini

Genus *Hister* Linnaeus, 1767

1767. *Hister* Linnaeus, *Syst. Nat.*, ed. 12, 2 : 566.

*Hister puncticephalus* sp. nov.

Body oval, somewhat convex, black and opaque. Head transverse, weakly convex, clypeus and frons densely and finely punctate, frontal stria entire, weakly sinuous anteriorly, deepest on the eyes, labrum rectangular with a small tip anteriorly, finely punctate, mandibles robust concave, bent with sharp tips, densely and finely punctate. Antennae brown, club, greyish and pubescent. Pronotum broader than long, weakly bisinuous at the base, lateral sides gradually narrowing anteriorly and forming acute angles with anterior margin strongly notched anteriorly, margins pubescent, marginal striae fine and terminating behind the eyes, the external lateral stria terminates in front after passing the angle, shortened at the base, the inner lateral stria entire, sinuous and continues behind the head, almost reaching the base, punctate; the space between two striae finely and sparsely punctate anteriorly. Scutellum small, black and triangular. Elytra broader than long, its apical margin weakly rounded, dorsal striae 1- 4 entire, 5<sup>th</sup> and sutural apical, 5<sup>th</sup> reaching almost middle, sutural little shorter, all punctate, humeral stria fine, oblique, subhumeral strong, approaching humeral callus, occasionally with rudimentary apendices, subhumeral fossetts grooved with two striae, lateral margins finely punctate. Propygidium transverse, weakly bifoveolate, sparsely punctate. Pygidium almost triangular, weakly convex, densely punctate. Prosternum narrow rounded at the base, prosternal lobe extending a little beyond the anterior angles of pronotum. Mesosternum notched anteriorly, stria entire. Anterior tibiae strongly flattened with 3-blunt teeth, posterior tibiae with double rows of compact spines.

*Measurements* : Length 6.67–8.67 mm.; Width 4.33–4.89 mm.

*Holotype* : 1 ex., India : Rajasthan: Pichhola Lake in Udaipur Dist., 29.iii.1996; coll. N.S. Rathore and S. Kumar. (Reg. No. 7274/5).

*Paratype* : 1 ex., India : Rajasthan: Pichhola Lake in Udaipur Dist., 29.iii.1996; coll. N.S. Rathore and S. Kumar. (Reg. No. 7275/5).

*Remarks* : This species is closely related to *H. opacus* Schmidt of Koraput (Orissa) but differs considerably by the characters of dorsal striae and pronotal striae. In *H.*

*opacus* dorsal striae 1-3 entire, 4 apical, 5<sup>th</sup> and sutural stria either absent or reduced but in *puncticephalus* sp. nov. 1-4 entire, 5<sup>th</sup> and sutural apical, reaching almost to the middle. In *H. opacus* external lateral striae on pronotum extends upto middle where as in the present species it extends more near to the base.

### Family STAPHYLINIDAE

The members of the family Staphylinidae are commonly known as 'rove beetles' and is also one of the largest family of the order Coleoptera. The habits of Staphylinidae are very varied and found usually in dung, decaying vegetable refuse, dead birds and animals, moss moist dead leaves etc. They are mostly carnivorous, some of them are vegetable feeders and large number of them are found in fungi and in sap, flowers, decaying wood, burrows on the bank of pond, river, lake and seashore etc. They feed on the various small insects, larvae, pupae etc. and also found to be associated with ants. Some are very conspicuous, brilliantly coloured and widely distributed throughout the world (Kraatz, 1859; Cameron, 1930, 1931 and 1932; Biswas and Sengupta, 1989).

### Subfamily OXYTELINAE

### Genus *Bledius* Leach, 1819

1819. *Bledius* Leach, *The entomologist's useful compendium.*, London : 496.

### *Bledius* (s. str.) *marusthanicus* Biswas and Sengupta

1989. *Bledius* (s. str.) *marusthanicus* Biswas and Sengupta, *Rec. zool. Surv. India, Occ. paper No.*, **122** : 1- 46. Figs. 1-133.

*Material examined* : 2 exs., 12.ix.1994, 9 exs., 2.iv.1996, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan

### *Bledius* (*Pucerus*) *gracilicornis* Kraatz

1859. *Bledius* (*Pucerus*) *gracilicornis* Kraatz, *Arch. Naturgesch*, **25** (1) : 169.

1989. *Bledius* (*P.*) *gracilicornis*: Biswas and Sengupta, *Rec. zool. Surv. India, Occ. Paper No.*, **122** : 1- 46 figs. 1-133.

*Material examined* : 1 ex., 12.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan, Tamil Nadu.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

Subfamily PAEDERINAE

Genus *Paederus* Fabricius, 1775

1775. *Paederus* Fabricius, *Syst. Ent.*: 268.

*Paederus fuscipes* Curtis

1823-40. *Paederus fuscipes* Curtis, *Ent. Brit.*, 3 : 108.

*Material examined* : 1 ex., 12.ix.1994, 2 exs. 13.iii.1995 1ex., 2.vi.1996, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Bihar, Tripura, West Bengal, Meghalaya, Madhya Pradesh, Rajasthan, Karnataka.

*Elsewhere* : Sri Lanka and also rest of the world except America.

*Remarks* : This species is recorded for the first time from Rajasthan.

*Paederus melampus* Erichson

1839-40. *Paederus melampus* Erichson, *Gen. Spec. Staph.*, : 660.

*Material examined* : 14 exs., 12.x.1994, 2 exs., 12.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India: Maharashtra, Rajasthan. Elsewhere: Bangladesh.

*Remarks* : This species is recorded for the first time from Rajasthan.

Genus *Charichirus* Sharp, 1889

1889. *Charichirus* Sharp, *Ann. Mag. Nat. Hist.*, 2 (6) : 262.

*Charichirus chinensis* (Boh.)

—?—*Lathrobium chinensis* Boh., *Resa Engen.* : 32.

—?—*Charichirus chinensis* : Cameron, *Fauna Brit. India*, 2 : 167-168.

*Material examined* : 1 ex., 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : West Bengal, Tripura, Rajasthan.

*Elsewhere* : Sri Lanka and Japan.

*Remarks* : This species is recorded for the first time from Rajasthan.

Genus *Cryptobium* Mannerheim, 1830

1830. *Cryptobium* Mannerheim, Brach., : 38.

*Cryptobium cylindroderum* Champion

1925. *Cryptobium cylindroderum* Champion, Ent. Men. Mag., 59 : 107.

1931. *Cryptobium cylindroderum*: Cameron, Fauna of British India, 2 : 234.

*Material examined* : 1 ex., 10.iii.1995, 1 ex., 26.viii.1995, 3 exs., 31.iii.1997, coll. N. S Rathore and S. Kumar.

*Distribution* : India : Uttar Pradesh, Rajasthan.

*Remarks* : This species is recorded for the first time from Rajasthan.

*Cryptobium abdominale* var. *indicum* Kraatz.

1859. *Cryptobium pygiale* Kraatz, Arch. Naturgesch., 25 (1) : 121.

1859. *Cryptobium pygiale* var. *indicum* Kraatz, Arch. Naturgesch., 25 (1) : 121.

1931. *Cryptobium abdominale* var. *indicum* Cameron, Fauna British India, 2 : 243-244.

*Material examined* : 2 exs., 12.x.1994, coll. N. S. Rathore and S. Kumar.

*Distribution* : India: West Bengal, Rajasthan.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

## Subfamily STAPHYLININAE

Genus *Indoscitalinus* Heller, 1900

1900. *Indoscitalinus* Heller, Abh. Mus. Dresd., 9 (5) : 5.

*Indoscitalinus anachoreta* (Erichson)

1839-40. *Indoscitalinus anachoreta* Erichson, Gen. Spec. Staph., : 316.

1932. *Indoscitalinus anachoreta*: Cameron, Fauna British India, 3 : 37.

*Material examined* : 2 exs., 31.iii.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan and Tripura.

*Elsewhere* : Madagascar, Mauritius, S. China and Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

***Staphylinus* Linnaeus, 1758**

1758. *Staphylinus* Linnaeus, *Syst. Nat., ed.*, 10 : 421.

***Staphylinus (Platydracus) maculipennis* Kraatz**

1859. *Staphylinus maculipennis* Kraatz, *Arch. Naturgesch.*, 25 (1) : 77.

1932. *Staphylinus (P.) maculipennis* Cameron, *Fauna British India*, 3 : 196.

*Material examined* : 1ex., 11.iii.1995, 1ex., 26.viii.1995, 1exs., 31.iii.1997 coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Bihar, Rajasthan and Uttar Pradesh.

*Remarks* : This species is recorded for the first time from Rajasthan.

***Staphylinus (Platydracus) indicus* Kraatz**

1859. *Staphylinus indicus* Kraatz, *Arch. Naturgesch.*, 25 (1) : 75

1932. *Staphylinus (P.) indicus* Cameron, *Fauna British India*, 3 : 188-189.

*Material examined* : 2 exs., 9.iii.1995, 1 ex., 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan, Tamil Nadu and Uttar Pradesh.

*Elsewhere* : Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

**Family MELOIDAE**

The members of this family are commonly known as 'blister beetles' and owe their common name to the fact that a pharmaceutical product cantharidin is prepared from the dried insects. When these insects are handled, they exude a yellow fluid which contains cantharidin and causes blisters on human skin. The adults are conspicuously coloured, soft bodied, long legged phytophagous insects. Many species are harmful being pests of agricultural, horticultural and vegetable crops and also have the parasitic mode of life on wild bees and grasshoppers [Peringuey (1909), Shah (1979)].

**Genus *Psalydolytta* Peringuey, 1909**

1909. *Psalydolytta* Peringuey, *Trans. R. Soc. S. Africa*, 1 (1) : 254.

***Psalydolytta rouxi* (Laporte)**

1840. *Cantharis rouxi* Laporte, *Hist. Nat. Col.*, 2 : 274.

1917. *Psalydolytta rouxi*: Borchmann, *Junk's Col. Cat.*, 17 (69) : 103.

1954. *Psalydolytta rouxi*: Kaszab, *Acta Zool. hung.*, 1 (1-2) : 79, 102.

*Material examined* : 1 ex., 9.xi.1994, coll. N. S. Rathore and S. Kumar

*Distribution* : India : Bihar, Gujarat, Madhya Pradesh and Rajasthan.

*Remarks* : This species is recorded for the first time from Rajasthan.

### SUMMARY

The present paper deals with twenty-three species belonging to eighteen genera under seven families. Of which two species viz. *Paussus desneuxi* Fowler (Paussidae), *Helochares densus* Sharp (Hydrophilidae) are recorded for the first time from India. Seventeen species under fourteen genera belonging to six families are recorded here for the first time from Rajasthan with a description of a new species viz. *Hister puncticephalus* (Histeridae) : Chakraborty, S.K. from Rajasthan. First reference and recent valid names of genera and species have been given. Distributional data of each species has been given from the published records as well as actual study of the specimens. Selected synonyms, collection data of each species have also been given.

### ACKNOWLEDGEMENTS

Authors are highly indebted to Dr. R.A. Khan, Director-in-charge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, for giving laboratory facilities. Thanks are also due to Dr. G.K. Srivastava, Additional Director (Retd.) and Dr. S.K. Mitra, Joint Director (Retd.) for suggestions and encouragement to complete the work and to the Officer-in-charge, Desert Regional Station, Jodhpur for sending the material for the present study.

### REFERENCES

- Andrews, H.E. 1930. *Catalogue of India Insects*, Part 18 : Carabidae : 1 388.
- Bickhardt, H. 1910. Histeridae, *Coleopterorum catalogus*, Pars 24, W. Junk and S. Schenkling ed. : 1-137.
- Bickhardt, H. 1913. Coleoptera III. Histeridae. *Rec. Ind. Mus.*, 8 : 121-125.
- Biswas, D.N. and Sengupta, T. 1989. Revision of the Indian *Bledius* Leach (Coleoptera: Staphylinidae). *Rec. zool. Surv. India, Occ. Paper No.*, 122 : 1-46, figs 1-133.
- Borelli, F.A. 1809. Observations entomologiques (Caraben). *Memorie Acad. Sci. Torino*, 18 : 21-78.

- Cameron, M. 1930. *The Fauna of British India* including Ceylon and Burma, Coleoptera: Staphylinidae, Vol. I, London, : v + 463 pp., 3 pl.
- Cameron, M. 1931. *The Fauna of British India* including Ceylon and Burma, Coleoptera: Staphylinidae, Vol II, London, : iii + 257 pp., 2pl.
- Cameron, M. 1932. *The Fauna of British India* including Ceylon and Burma, Coleoptera: Staphylinidae, Vol. III, London, : v + 433. pp., 4 pl.
- Chakraborty, S.K. and Biswas, S. 1995. Insecta : Coleoptera : Histeridae. *Fauna of West Bengal, State Fauna Series, 3(Part 6-A) : 169–199. Zool. Surv. India.*
- Chaudoir, B.M. 1876. Monographic des chlènièns, *Annali Mus. Civ. Stor. nat. Giacomo Doria, 8 : 1- 315.*
- Sharma, S.K. 1998. Aquatic biota of Rajasthan. In: *Reviving wetlands, Issues and challenges.* (ed.) S. K. Verma. Himanshu Publications, Udaipur : 75-94.
- Chatterjee, S.K. and Mukhopadhyay, P. 2005. Insecta : Coleoptera : Scarabaeidae. In : *Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series, 6 : 133-139.* Edited and Published by the Director, *Zool. Surv. India, Kolkata.*
- d'orchymont, A. 1928. Catalogue of Indian Insects, Part 14 : 1–146, Govt. of India Publication, Hydrophilidae : Coleoptera.
- Erichson, W.F. 1834. Unberischt der Histeroides in *Klug Jahrb. Insekter Kunde, 1 : 83–208.*
- Fabricius, J.C. 1781. *Species Insectorum. Hamburgi and Kilonii, 1 : viii + 552.*
- Fowler, W.W. 1912. *The Fauna of British India* including Ceylon and Burma, Coleoptera: Genl. Introduction and Cicindelidae and Paussidae : 529 (Taylor and Francis, London).
- Guignot, F. 1954. *Dytiscidae recolte's par la yale North India Expedition on Kashmir et. an. Punjab.*
- Knisch, A. 1924. *Coleopterorum Catalogus, (S. Schkling edited), 14(79) : 306.*
- Kraatz, G. 1859. Staphylinen- Fauna von Ostindien insbesondere der Insel–Ceylon. *Archiv fur Naturgeschichte, 25 : 1-193, 3 pl.*
- Sharma, S.K. 1998. Aquatic biota of Rajasthan. In : *Reviving wetlands, Issues and challenges.* (ed.) S. K. Verma. Himanshu Publications, Udaipur : 75-94.
- Mukhopadhyay, P. Chakraborty, S.K. Biswas, D.N. Halder, S.K. Ghosh, S.K. Chakraborty, P. and Sengupta, S. 2005. Coleoptera. In : *Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series, 6 : 119-132.* Edited and Published by the Director, *Zool. Surv. India, Kolkata.*

- Peringuey, L. 1909. Descriptive catalogue of the Coleoptera of South Africa. Family Meloidae. *Trans. R. Soc. South Afr.*, 1 (1) : 165-292, plate 1-3.
- Saha, G.N. 1979. Revision of Indian Blister beetles (Coleoptera : Meloidae: Meloinae), 74 (Part-1) : 1-146.
- Saha, S.K., Halder, S.K. and Biswas, S. 1995. Insecta : Coleoptera : Adephaga : Fam. Rhysodidae, Paussidae and Cicindelidae. *Fauna of West Bengal, State Fauna Series*, 3(Part 6-A) : 1-51. *Zool. Surv. India*.
- Saha, S.K. and Sengupta, T. 1979a. On a collection of India *Chlaenius* Bonelli (Chlaeniini): Carabidae: Coleoptera) in Museum d'Histoire naturelle de Geneve with description of three new species. *Revue Suisse Zool.*, 86(2) : 419-425.
- Saha, S.K. and Sengupta, T. 1979b. Aspects of intraspecific variation in *Chlaenius bimaculatus* Dejean (Carabidae: Chlaeniini: Coleoptera) *Proc. Symp. Zool. Surv. India*, 1 : 27-40.
- Vazirani, T.G. 1968. Contribution to the study of Aquatic beetles (Coleoptera). 2. A review of the Subfamilies Noterinae, Laccophilinae, Dytiscinae and Hydroporinae (in part) from India. *Ori. Ins.*, 2 (3-4) : 217-341.
- Vazirani, T.G. 1977. Catalogue of Oriental Dytiscidae. *Rec. zool. Surv. India, Occ. Paper No.*, 6 : 1-111.

## **INSECTA : HYMENOPTERA : FORMICIDAE**

**N. TAK, N.S. RATHORE AND S. KUMAR**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### **INTRODUCTION**

Ants belong to family Formicidae of order Hymenoptera. They are social insects like honeybees, wasps and termites. Ants live in well-established nest or community with hundreds and thousands of individuals of distinct forms. There are three forms, the fertile female, the male and the worker. Very often there is more than one form of worker and in some cases the largest forms differ considerably from the smaller in structure, these are known as soldiers. A large number of ant species are found in houses living closely with man, in the gardens and they occupy almost every habitat. In spite of ants being so common, very little information is available on them especially from northwest India.

Binghams (1903) fauna is the main source of knowledge on ants. Chapman and Capco (1951) has provided checklist of the Ants. Chhotani and Ray (1976) described the Hymenoptera fauna of Rajasthan and dealt with few species of ants of desert region. Tak (1995) and Tak and Rathore (1996) have reported some species on ants of Jodhpur as well as of the Thar Desert.

The present studies are based on the material collected from the surrounding area of Pichhola Lake, Udaipur by the survey party of Desert Regional Station, Zoological Survey of India, Jodhpur. The paper deals with eleven ant species belonging to five sub-families and eight genera. Out of eleven species five are new records from Rajasthan.

### **SYSTEMATIC ACCOUNT**

Order	HYMENOPTERA
Family	FORMICIDAE
Subfamily	DORYLINAE Leach
Tribe	<b>Dorylini</b> Forel

***Dorylus (Typhlopone) labiatus* Shuckard**

*Material examined* : Many exs., 31.iii.1997, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Barmer, Jodhpur (Phalodi), Jaipur (Sambhar Lake), Udaipur, Ganganagar (Sriganganagar), Kotah (Main Lake), Nagaur (Lihorana), Jaisalmer (Mohangarh) and whole of India.

***Dorylus (Alaopone) orientalis* Westwood**

*Material examined* : 1 ex., 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Jodhpur (Phalodi), Gudha (Nagaur), Jhapog (Jaipur), Jaipur (Sambhar Lake), Udaipur and throughout India.

*Elsewhere* : Borneo, Java, Malay Peninsula, Sri Lanka, Sumatra, Nepal and China.

*Remarks* : Chhotani and Ray (1976) mentioned this species from dry areas of Rajasthan but now it is recorded from wet and hilly areas of Rajasthan, which is of ecological importance.

Subfamily CERAPACHYINAE Forel

Tribe Cerapachyini Forel

***Cerapachys (Cerapachys) risi* Forel**

*Material examined* : 10 exs., 9.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Udaipur and Sikkim.

*Elsewhere* : Myanmar extending to the Malay Peninsula.

*Remarks* : This species is recorded for the first time from Rajasthan.

***Cerapachys longitarsus* Mayr**

*Material examined* : 4 exs., 9.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Udaipur and Western India from Poona to Travancore.

*Remarks* : This species is recorded for the first time from Rajasthan.

Subfamily MYRMICINAE Lepeletier

Tribe Solenopsidini Forel

***Solenopsis geminata* Fabricius**

*Material examined* : Many exs., 9.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Udaipur. Spread over both the hemispheres.

*Remarks* : This species is recorded for the first time from Rajasthan.

Tribe **Pheidologetini** Emery

*Pheidologeton affinis* Jerdon

*Material examined* : Many exs., 9.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Udaipur, Western India from Poona to Travancore, Bengal Assam.

*Elsewhere* : Sri Lanka and Myanmar.

*Remarks* : This species is recorded for the first time from Rajasthan.

Tribe **Tetramorini** Emery

*Triglyphothrix walshi* Forel

*Material examined* : 1 ex., 3.iv.1996, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Dungarpur, Udaipur. Western India, Himachal Pradesh, Karnataka, Bengal and NW India.

*Elsewhere* : Sri Lanka.

Subfamily **DOLICHODERINAE** Forel

Tribe **Tapinomini** Emery

*Tapinoma (Micromyrma) melanocephalum* Fabricius

*Material examined* : 5 exs., 3.iv.1996, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Jodhpur, Dungarpur, Udaipur. Whole of India. Spread through the tropics of both the hemispheres.

Subfamily **FORMICINAE** Lepeletier

Tribe **Camponotini** Forel

*Camponotus (Tanaemyrmex) compressus* Fabricius

*Material examined* : 4 exs., 9.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Jaisalmer, Jodhpur, Jaipur (Gudha, Devdyani Kyars and Phulera), Nagaur (Kuni), Dungarpur and throughout India.

*Elsewhere* : Sri Lanka, Myanmar, Russia, Arabia and Africa.

***Camponotus (Dinomyrmex) angusticollis* Jerdon**

*Material examined* : 3 exs., 9.ix.1994, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Jaisalmer, Jodhpur. Western and Central India, Assam.

*Elsewhere* : Myanmar.

***Polyrhachis (Myrmhopla) simplex* Mayr**

*Material examined* : 5 exs., 9.iii.1995, 2 exs., 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Distribution* : India : Rajasthan : Udaipur and throughout India.

*Elsewhere* : Myanmar and Sri Lanka.

*Remarks* : This species is recorded for the first time from Rajasthan.

**SUMMARY**

The paper deals with eleven species of Formicidae: Hymenoptera belonging to eight genera under five sub-families from adjacent areas of Pichhola Lake, Udaipur with five new records from Rajasthan. The collection data, distribution ranges within India and outside have also been provided.

**ACKNOWLEDGEMENTS**

We are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Z.S.I., Kolkata for support of our research work. Gratitude is expressed towards the Officer-in-charge, D.R.S., Z.S.I., Jodhpur for providing facilities and for advice to improve the quality of this communication. Late Prof. Ishwar Prakash also went through the manuscript critically and gave useful suggestions. We are grateful to him.

**REFERENCES**

- Bingham, C.T. 1903. *Fauna British India* (Hymenoptera). London, 2 : xix + 506, pl. 1.
- Chapman, J.W. and Capco, S.R. 1951. *Checklist of the Ants* (Hymenoptera : Formicidae) of Asia, Monograph of the Institute of Science and Technology, Manila, No. 1 : 327.
- Chhotani, O. B. and Ray, K. K. 1976. Fauna of Rajasthan, India, Hymenoptera Rec. *zool. Surv. India.*, 71 : 13 – 49.
- Tak, N. 1995. Studies on ants (Formicidae) of Rajasthan-I Jodhpur. *Hexapoda*, 7(1): 17-28.
- Tak, N. and Rathore, N.S. 1996. Ant (Formicidae) Fauna of Thar Desert. In : *Faunal Diversity in the Thar Desert: Gaps in Research*. (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash : 271-276.

# Chapter 7

## Mollusca



S.C. Mitra, A. Deyn & S. Barua

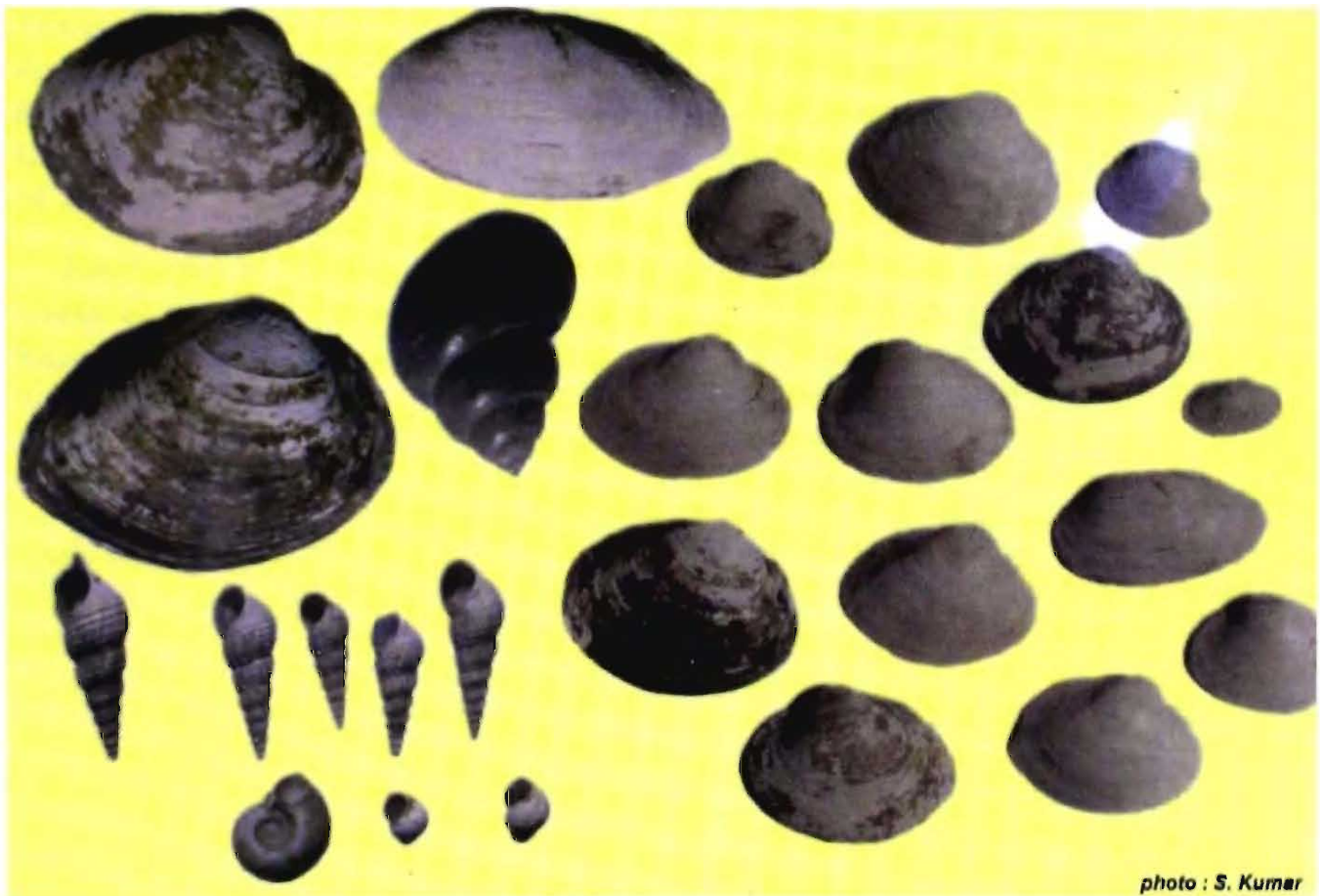


photo : S. Kumar

Molluscan fauna of Pichhola Lake

## **MOLLUSCA**

**S.C. MITRA, A. DEY AND S. BARUA**

*Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053*

### **INTRODUCTION**

Studies on molluscan fauna of Pichhola Lake are in continuation of the project on studies and conservation of the faunal resources of the wetland ecosystems of India. The studies on molluscs of Chilika lagoon (Subba Rao *et al.*, 1995), Kabar Lake (Surya Rao *et al.*, 2002 b), Renuka Lake (Surya Rao and Mitra, 2000) and Ujani Lake (Surya Rao *et al.*, 2002 a) are already completed in this series. Pichhola Lake, situated in Udaipur district of Rajasthan, is an important freshwater wetland in the semi-arid zone of northwest India.

Freshwater molluscs of India are one of the fairly worked out groups. Important works are those by Preston (1915) and Subba Rao (1989). Freshwater molluscs of Rajasthan State were comprehensively studied by Ray and Mukherjee (1969). Some other publications are by Choubisa and Sharma (1986), Rathore and Bohra (1987) and Kumar and Ahmed (1998).

Ray and Mukherjee (1969) reported thirteen species and subspecies from Udaipur in total, out of which two species of gastropods were from Pichhola Lake. Incidentally this report included only one species of bivalve from Udaipur, but none from Pichhola Lake.

The present work is based on material collected by the recent surveys undertaken from the Desert Regional Station, Zoological Survey of India, Jodhpur, during the years 1994-1997. The report includes ten species and a few sub-specific forms, collected from Pichhola Lake, Udaipur district Rajasthan. *Lymnaea (P) acuminata f. patula* (Troschel) is included here on the basis of old collections present in National Zoological collection of Zoological Survey of India and has not been collected during the recent surveys. The classification followed here is that of Vaught (1989).

### SYSTEMATIC ACCOUNT

Class GASTROPODA  
Order MESOGASTROPODA  
Family VIVIPARIDAE

Genus *Bellamyia* Jousseau, 1886

*Bellamyia bengalensis f. typica* (Lamarck)

1822. *Paludina bengalensis* Lamarck, *Hist. nat. Anim. sans. vert.*, 6(2) : 174.

1989. *Bellamyia bengalensis f. typica* Subba Rao, *Handbook Freshwater Molluscs of India* : 45, fig. 55.

*Material examined* : 1 ex., 1.ix.1994; 14 exs., 8.ix.1994; 6 exs., 24.viii.1995; 1 ex., 1.iv.1996, coll. N. S. Rathore and S. Kumar.

*Measurements* (in mm.) :

Length	Diameter	Height of the aperture
32.20 - 23.15	22.40 - 16.35	15.80 - 11.90

*Distribution* : India : Rajasthan (Pali, Udaipur), common throughout rest of the country.

*Elsewhere* : Bangladesh, Myanmar and Sri Lanka.

*Remarks* : Spire and bodywhorl equal in height, whorls well rounded, apex pointed, broad and narrow, spiral bands irregularly arranged, rim of aperture often black.

Family BITHYNIIDAE

Genus *Gabbia* Tryon, 1865

*Gabbia orcula var. producta* (Nevill)

1884. *Bithynia orcula var. producta* Nevill, *Hand list Moll. Indian Mus.*, 2 : 37.

1969. *Alocinma orcula var. producta* Ray and Mukherjee, *Rec. zool. Surv. India*, 61 : 420, pl. 19, figs. 1, 1a.

1989. *Gabbia orcula var. producta* Subba Rao, *Handbook Freshwater Molluscs of India* : 77, fig. 142.

*Material examined* : 2 exs., 12.ix.1994; 5 exs., 19.ix.1994; 3 exs., 10.iii.1995; 1 ex., 24.viii.1995; 1 ex., 27.viii.1995; 24 exs., 12.iii.1996; 4 exs., 29.3.1997; 1 ex., 27.viii.1997, coll. N. S. Rathore and S. Kumar.

*Measurements* (in mm) :

Length	Diameter	Height of the aperture
6.00 - 4.80	4.30 - 3.60	3.00 - 2.50

**Distribution** : India : Andhra Pradesh, Assam, Bihar, Maharashtra, Punjab, Rajasthan (Jaipur, Udaipur), Uttar Pradesh and West Bengal.

**Remarks** : This variety is fairly constant and differs from the typical form in being a little narrower with a more elongate spire. However, these variations in shell characters are not linked to any geographical isolation.

Family THIARIIDAE

Genus *Thiara* Roeding, 1798

Subgenus *Melanoides* Olivier, 1807

*Thiara (Melanoides) tuberculata* (Mueller)

1774. *Nerita tuberculata* Mueller, *Hist. Verm. Terr. Fluv.*, 2 : 191.

1969. *Melanoides (Melanoides) tuberculata* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4) : 420, pl. 19, figs. 2, 2a.

1989. *Thiara (Melanoides) tuberculata* Subba Rao, *Handbook Freshwater Molluscs of India* : 103, figs. 183, 184.

**Material examined** : 6 exs., 17.ix.1994, coll. N. S. Rathore and S. Kumar.

**Measurements** (in mm) :

Length	Diameter	Height of the aperture
26.50 - 11.40	11.80 - 4.50	12.70 - 4.50

**Distribution** : India : Rajasthan (Udaipur), throughout rest of the country except Kashmir.

**Elsewhere** : North and South Africa, Eastern Mediterranean countries, S.E. Asia, S. China, Malaysia, Malaya Archipelago, N. Australia, Pacific Islands and north to the Ryukyu, Islands of Japan and New Hebrides.

**Remarks** : Shell variable, elongate-turreted, spire long, whorls rounded coarsely sculptured with vertical ribs and spiral striae, dark red-brown dots and streaks irregularly arranged on the surface.

Order BASOMMATOPHORA

Family LYMNAEIDAE

Genus *Lymnaea* Lamarck, 1799

Subgenus *Pseudosuccinea* Baker, 1908.

*Lymnaea (Pseudosuccinea) acuminata f. typica* Lamarck

1822. *Lymnaea acuminata* Lamarck, *Hist. nat. Anim. Sans. Vert.*, Paris, 6(2) : 160.

1969. *Lymnaea (Pseudosuccinea) acuminata f. typica* Ray and Mukherjee, *Rec. zool. Surv. India*, **61** (3 and 4) : 425, pl. 19, figs. 6, 6a.

1989. *Lymnaea (Pseudosuccinea) acuminata f. typica* Subba Rao, *Handbook Freshwater Molluscs of India* : 126, figs. 258-259.

*Material examined* : 11 exs., 10.iii.1995; 4 exs., 29.iii.1997, coll. N. S. Rathore and S. Kumar.

*Measurements* (in mm) :

Length	Diameter	Height of the aperture
25.70 - 18.60	13.90 - 9.65	20.00 - 15.20

*Distribution* : India : Rajasthan (Jaipur, Jodhpur, Sirohi, Udaipur) : common throughout rest of the country.

*Elsewhere* : Bangladesh, Myanmar and Pakistan.

*Remarks* : Shell variable, thin and ovate, with a short acuminata spire, body whorl large and inflated, a little angular above, aperture broad, outer lip expanded.

***Lymnaea (Pseudosuccinea) acuminata f. patula* Troschel**

1837. *Limnaea patula* Troschel in *Wiegmann's Arch. f. naturges. Berlin*, **3** : 167.

1969. *Lymnaea (Pseudosuccinea) acuminata f. patula*: Ray and Mukherjee, *Rec. zool. Surv. India*, **61**(3 and 4) : 426, pl. 19, figs. 7, 7a.

1989. *Lymnaea (Pseudosuccinea) acuminata f. patula*: Subba Rao, *Handbook Freshwater Molluscs of India*: 127, figs. 256, 257.

*Material examined* : 3 exs., 24.xii.1965, coll.? In National Zoological collection, ZSI, Kolkata.

*Measurements* (in mm) :

Length	Diameter	Height of the aperture
21.80 - 12.60	11.75 - 5.00	15.90 - 9.80

*Distribution* : India : Rajasthan (Udaipur), common throughout rest of the country.

*Elsewhere* : Myanmar, Nepal and Pakistan.

*Remarks* : Shell slightly narrower than in typical form, spire a little larger, anterior end of aperture tapering.

***Lymnaea (Pseudosuccinea) luteola f. typica* Lamarck**

1822. *Limnaea luteola* Lamarck, *Hist. nat. Anim. Sans. Vert.*, Paris, 6(2) : 160.

1969. *Lymnaea (Pseudosuccinea) luteola f. typica* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4) : 427, pl. 19, figs. 10, 10a.

1989. *Lymnaea (Pseudosuccinea) luteola f. typica* Subba Rao, *Handbook Freshwater Molluscs of India* : 129, figs. 275-276.

**Material examined** : 6 exs., 12.ix.1994; 3 exs., 10.iii.1995; 2 exs., 12.iii.1995; 2 exs., 29.iii.1997, coll. N.S. Rathore and S. Kumar.

**Distribution** : India : Rajasthan (Pali, Sirohi, Udaipur), common throughout rest of the country.

**Elsewhere** : Bangladesh, Myanmar, Nepal and Pakistan.

**Remarks** : Shell thin, ovate, spire well produced with a rather obtuse apex; bodywhorl less inflated and a bit compressed laterally; aperture not much wide.

## Family PLANORBIDAE

Genus ***Indoplanorbis*** Annandale and Prashad, 1920.

***Indoplanorbis exustus* (Deshayes)**

1834. *Planorbis exustus* Deshayes, *Belang. voy. Ind. Orient. Zool. Moll.*, Paris : 417, pl. 1 figs. 11-13.

1969. *Indoplanorbis exustus* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4) : 422, pl. 19, fig. 5.

1989. *Indoplanorbis exustus* Subba Rao, *Handbook Freshwater Molluscs of India* : 142, figs. 326, 327.

**Material examined** : 1 ex., 12.ix.1994; 3 exs., 10.iii.1995; 2 exs., 24.viii.1995 1 ex., 27.viii.1995; 3 exs., 1.iv.1996; 1 ex., 29.iii.1997, coll. N.S. Rathore and S. Kumar.

**Distribution** : India : Rajasthan (Ajmer, Barmer, Bikaner, Churu, Dungarpur, Ganganagar, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar and Udaipur), widely distributed throughout rest of the country.

**Elsewhere** : Bangladesh, China, Iran and Indonesia.

**Remarks** : Shell thick and large, striated, discoidal with a sunken spire, whorls well rounded and aperture ear shaped.

Genus ***Gyraulus*** Charpentier, 1837

***Gyraulus convexiusculus* (Hutton)**

1849. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, 18 (2) : 657.

1969. *Gyraulus convexiusculus* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4) : 424, pl. 19, fig. 4.

1989. *Gyraulus convexiusculus* Subba Rao, *Handbook Freshwater Molluscs of India* : 154, figs. 362-364.

*Material examined* : 4 exs., 24.xii.1961, coll. ?.; 3 exs., 12.ix.1994; 21 exs., 10.iii.1995, 6 exs., 12.iii.1995; 1 ex., 1.iv.1996; 18 exs., 29.iii.1997, coll. N. S. Rathore and S. Kumar.

*Measurements* (in mm.) :

Height	Diameter
11.58 – 1.20	6.90 – 3.20

*Distribution* : India: Rajasthan (Jaipur, Nagaur, Sirohi, Udaipur); common throughout rest of the country.

*Elsewhere* : Iran to Philippines and Japan.

*Remarks* : Shell small and disc like, umbilicate, semitransparent, whorls 4-5, bodywhorl angulate at the periphery; aperture obliquely oval.

Class BIVALVIA  
Order UNIONOIDA  
Family UNIONIDAE

Genus *Lamellidens* Simpson, 1900

*Lamellidens corrianus* (Lea)

1834. *Unio corrianus* Lea, *Trans. Amer. Phil. Soc, Philadelphia*, 6 : 65, pl. 9, fig. 25.

1969. *Lamellidens corrianus* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4) : 431, pl. 20, fig. 1.

1989. *Lamellidens corrianus* Subba Rao, *Handbook Freshwater Molluscs of India* : 165, figs. 386, 387.

*Material examined* : 1 valve, 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Measurements* (in mm.):

Length	Width
60.25	31.80

*Distribution* : India : Rajasthan, widely distributed throughout the country.

*Elsewhere* : Bangladesh and Myanmar.

*Remarks* : Shell elongate, uniformly dark brown, inflated at the umbonal region, dorsal margin rather straight and long; anterior end short, posterior end subangulately pointed; two cardinals in each valve.

Genus *Parreysia* Conrad, 1853

Subgenus *Parreysia* s. str.

*Parreysia (Parreysia) favidens* sub sp. *deltae* (Benson)

1862. *Unio favidens* var. *deltae* Benson, *Ann. Mag. nat. Hist.*, 10 : 189.

1989. *Parreysia (Parreysia) favidens* sub sp. *deltae* Subba Rao, *Handbook Freshwater Molluscs of India* : 181, figs. 470, 471.

1992. *Parreysia (Parreysia) favidens* var. *deltae* Mitra and Dey, *Fauna of West Bengal, State Fauna Series*, 3(Part-9) (Mollusca) : 30.

*Material examined* : 6 valves, 10.iii.1995, coll. N.S. Rathore and S. Kumar.

*Measurements* (in mm.) :

Length	Width
26.50	18.60

*Distribution* : India : Rajasthan (Udaipur), Uttar Pradesh and West Bengal.

*Remarks* : Shell more rounded greenish yellow, posterior margin subangulate, umbonal region strongly sculptured; cardinal teeth narrower. This subspecies is recorded for the first time from the state of Rajasthan.

## SUMMARY

In total ten species (including a few infra specific forms) under eight genera and six families are recorded from Pichhola lake, out of which two species under two genera and a single family are bivalves and the rest are gastropods.

There is no special significance in the occurrence of these molluscs in the lake. All these species are among the common freshwater molluscan species of India having wide range of distribution across the country. Out of the two bivalves, *Parreysia (P) favidens* sub sp. *deltae* (Benson) is recorded for the first time from Rajasthan.

## ACKNOWLEDGEMENTS

The authors are grateful to the Director-In-charge, Zoological Survey of India for facilities to under take this work. Sincere thanks are also due to the Officer-in-charge, Desert Regional Station, Jodhpur for putting the material at our disposal for studies.

## REFERENCES

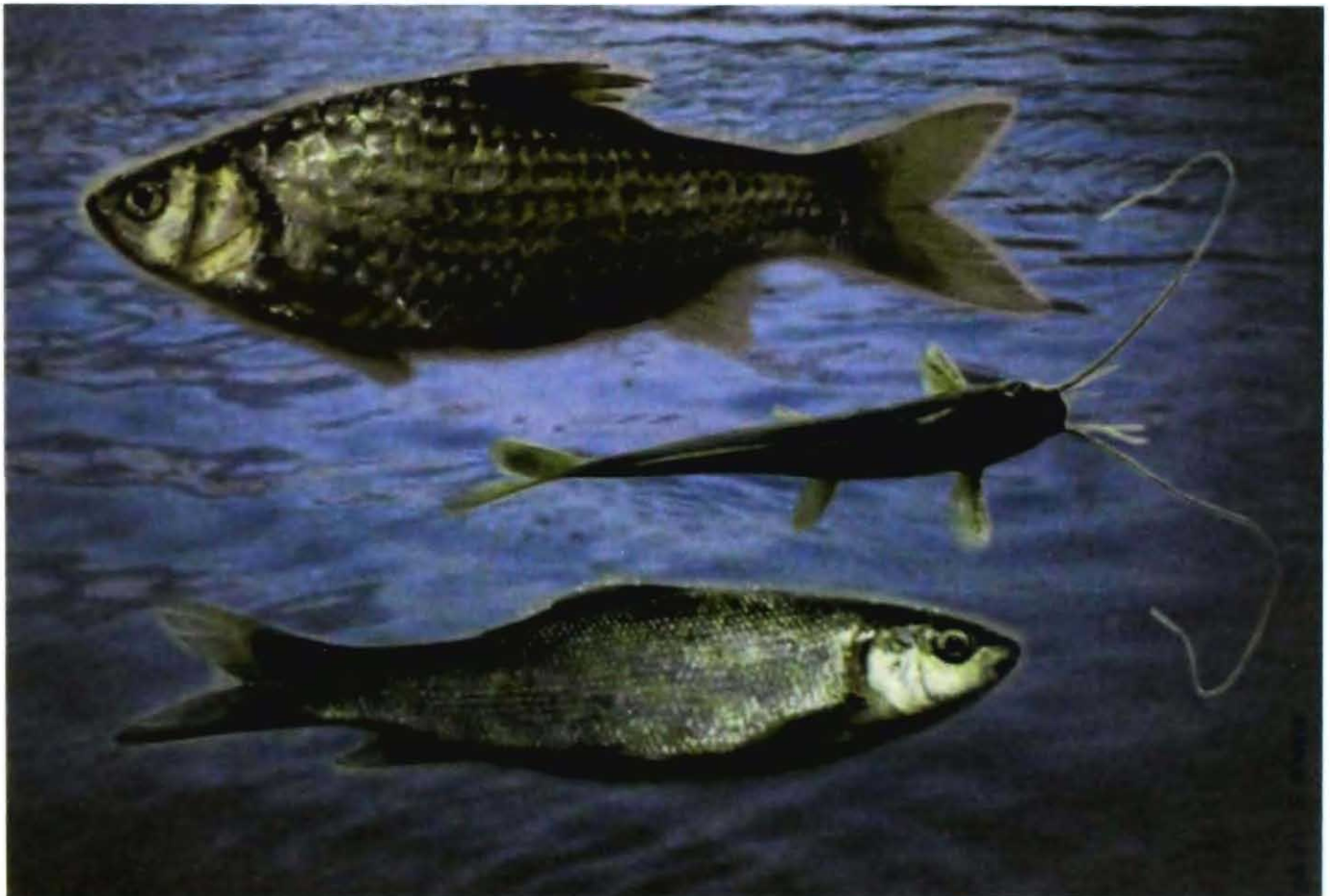
- Choubisa, S.L. and Sharma, P.N. 1986. Incidence of larval trematodes infection and their seasonal variations in the freshwater molluscs of southern Rajasthan. *Rec. zool. Surv. India*, **83**(1&2) : 69-80.
- Kumar, Seema and Ahmed, S.I. 1998. New distributional record of *Lymnaea* (*Pseudoisuccinea*) *acuminata* F. *typica* (Lamarck) (Mollusca: Gastropoda: Lymnaeidae) from the Thar Desert (Rajasthan). *Indian Forester*, **124**(1) : 77-78.
- Preston, H.S. 1915. *The Fauna of British India, Mollusca* (Freshwater Gastropoda and Pelecypoda), : xi + 244pp, text figs 1-29.
- Rathore, N.S. and Bohra, P. 1987. Mollusca fauna of Lake Kailana (Jodhpur, India). *Oikassay*, **4**(1) : 11-20.
- Ray, H.C. and Mukherjee, A. 1969. Fauna of Rajasthan, India, Part-3, Mollusca. *Rec. zool. Surv. India*, **61**(3-4) : 403-435, pl. 18-20.
- Subba Rao, N.V. 1989. *Handbook : Freshwater Mollusca of India* : xxii + 289 pp, figs. 1-638. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Subba Rao, N.V., Surya Rao, K.V. and Manna, R.N. 1995. Mollusca. In : *Fauna of Chilika Lake, Wetland Ecosystems Series*, **1** : 391-468. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Surya Rao, K.V. and Mitra, S.C. 2000. Mollusca. In : *Fauna of Renuka Wetland, Wetland Ecosystems Series*, **2** : 17-20. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Surya Rao, K.V., Mitra, S.C. and Maitra, S. 2002 a. Mollusca: In : *Fauna of Ujani (Maharashtra), Wetland Ecosystems Series*, **3** : 133-142. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Surya Rao, K.V., Mitra, S.C. and Ramakrishnan. 2002 b. Mollusca. In : *Fauna of Kabar Lake Wetland (Bihar), Wetland Ecosystem Series*, **4** : 57-63. Edited and Published by the Director, *Zool. Surv. India*, Kolkata.
- Vaught, K.C. 1989. A classification of the living Mollusca (ed.) R.T. Abbott. *American Malacologists*, Florida : 1-192.

# Chapter 8

## Pisces



S. Kumar and N.S. Rathore



New Records from Pichhola Lake

## PISCES

**S. KUMAR AND N.S. RATHORE**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### INTRODUCTION

Rajasthan waters have been very productive from the fisheries point of view and some of the most productive lakes of India are situated in this Udaipur region Vyas, (1986), Jhingran (1989) and Kohli *et al.* (1998). Fish fauna of Rajasthan wetlands have been extensively studied by Anonymous ?, Hora and Mathur (1952), Mathur (1952), Krishna and Menon (1958), Datta *et al.* (1961), Dubey and Mehra (1962), Moona (1963), Dhawan (1967), Tiwari (1968), Datta and Majumdar (1970), Mathur and Yazdani (1973), Durve and Rajbanshi (1975), Durve (1976), Durve and Kakkar (1977, 1979), Mathur (1977), Chaudhary (1978), Johal and Dhillon (1981), Johal (1982), Sharma and Johal (1982), Saxena (1984), Sharma *et al.* (1984), Gupta and Kulshreshta (1985), Sharma and Durve (1985), Johal and Sharma (1986), Nama (1987), Ajithkumar (1990, 1991, 1993), Sharma (1991), Sharma and Kulshreshta (1991), Ajithkumar and Asthana (1993), Ajithkumar and Mittal (1993), Ajithkumar and Sankar (1993), Johal *et al.* (1993), Kumar and Asthana (1993), Ajithkumar *et al.* (1995), Saxena and Rathore (1995), Yazdani (1996) and Kumar and Rathore (1999).

The Lake Pichhola has rich species diversity of Pisces group and a vast potential for the growth of fresh water fisheries. The lake not only receives drained water from the surrounding catchment area of Aravalli hills but major water also seasonally flows into the lake from Sisarma River. The fish species diversity varies greatly from time to time as many allochthonous fish species comes through the Sisarma riverine system. Dhawan (1967), Durve and Rajbanshi (1975) and Sharma and Durve (1985) have made some publications on fish fauna of this lake. They reported a total of 26 genera and 35 species of the fishes. In the year 1973 the lake was reduced to small muddy pool owing to the drought conditions of two consecutive years 1971 and 1972 resulting in mass mortality of fishes (Durve and Rajbanshi, 1975). Species of *Oxygaster* and *Clarius* were reported at that time but it seems that they did not perpetuate in the lake water and hence not recorded later.

In the present study, 26 species are identified from the lake water out of which three species viz. *Catla catla*, *Labeo fimbriatus* and *Aorichthys aor* are reported for the

first time. The fish species were identified from the collections of the fisherman's catch and photographs were taken to avoid collection of specimens due to their large size, weight and numbers (Plate-1). The classification followed is that of Talwar and Jhingran (1991). The systematic account is given for all the fishes so far recorded from the lake waters. Single asterisk (\*) represents fishes recorded during the present study and double asterisk (\*\*) as new records. A total of 42 species belonging to 12 families are so far recorded (Table-1) and described.

### SYSTEMATIC ACCOUNT

Class OSTEICHTHYES  
Subclass ACTINOPTERYGII  
Order OSTEOGLOSSIFORMES  
Family NOTOPTERIDAE

Genus *Notopterus* Lacepede

*Notopterus notopterus* (Pallas) \*

1769. *Gymnotus notopterus* Pallas, *Spicil. Zool.*, 7 : 40, pl. 6, fig 2. (Type-locality: Indian Ocean).

1976. *Notopterus notopterus* Misra, *Fauna of India*, Pisces (2<sup>nd</sup> ed.), 2 : 278, fig. 77 and pl. 7, fig. 3.

*Diagnostic characters* : Body oblong and strongly compressed, head also compressed. Dorsal fin near snout-tip than to base of caudal fin. Pectoral fins moderate, Anal and Caudal fins continuous. Scales minute.

*Distribution* : India.

*Elsewhere* : Pakistan, Nepal, Bangladesh, Myanmar, Thailand, Malay and Indonesia.

*Remarks* : Carnivorous. Inhabits fresh and brackish waters. Colour in life: Silvery-white with numerous grey spots on body.

Order CYPRINIFORMES  
Family CYPRINIDAE  
Subfamily CYPRININAE

Genus *Catla* Valenciennes

*Catla catla* (Hamilton-Buchanan) \*\*

1822. *Cyprinus catla* Hamilton-Buchanan, *Fishes of Ganges* : 287, 318, pl. 13, fig. 81. (Type-locality: Rivers and tanks of Bengal).

1878. *Catla buechanani* Valenciennes Day, *Fishes of India* : 553, pl. 134, fig. 5; Day, 1889, *Fauna Br. India*, Fishes, 1 : 287, fig. 99.

1966. *Catla catla* Jhingran, *FAO World Symposium on Warm-water Pond Fish Culture* : 18.

*Diagnostic characters* : Body deep, head enormously large with wide upturned mouth and big eyes, lower jaw prominent and protruding. Pectoral fins long, reaching up to pelvic fins. Caudal fin deeply forked. Scales large, silvery with dark grey above and silvery-white below.

*Distribution* : India : Northern India, transplanted into some rivers of peninsular India (Cauvery).

*Elsewhere* : Pakistan, Bangladesh, Nepal, Myanmar, Sri Lanka and China.

*Remarks* : Non-predatory, surface and mid water feeder. Hardy fish, successfully introduced for commercial purpose into almost all parts of India. Important food fish (carp). New record from Pichhola Lake.

#### Genus *Chagunius* Smith

##### *Chagunius chagunio* (Hamilton-Buchanan) \*

1822. *Cyprinus chagunio* Hamilton-Buchanan, *Fishes of Ganges*: pp. 295, 387. (Type-locality: Yamuna river and northern rivers of Bihar and Bengal); Hora, 1928, *J. Proc. Asiat. Soc. Beng.* (n. sr.), 23 (3) : 415.

1940. *Barbus (Chagunius) chagunio* Hora and Gupta, *J. Asiat. Soc. Beng.*, 6 (2) : 79.

*Diagnostic characters* : Body elongate, Mouth narrow with two pairs of barbels. Dorsal spine strong and serrated, Scales small. Colour in life silvery with a pinkish tinge.

*Distribution* : India : Brahmaputra and Ganga drainages along the Himalayan foothills.

*Remarks* : Found in rivers with rocky bottom and clear water. It is a good sport fish.

#### Genus *Cirrhinus* Cuvier

##### *Cirrhinius mrigala mrigala* (Hamilton-Buchanan) \*

1822. *Cyprinus mrigala* Hamilton-Buchanan, *Fishes of Ganges* : 279, 386, pl. 6, fig.79. (Type-locality: Ponds and freshwater rivers of Gangetic provinces).

1968. *Cirrhinus chaudhuryi* Srivastava, *Fishes of Eastern Uttar Pradesh* : 30. fig.17. (Type-locality: Gorakhpur, Uttar Pradesh); Dutt and Murthy, 1976, *Mem.. Soc. Zool. Guntur*, 1 : 17.

*Diagnostic characters* : Body streamlined, with blunt snout. Mouth broad with upper lip entire and lower lip indistinct. A single pair of short rostral barbels present. Dorsal fin as high as body. Pectorals shorter than head. Caudal fin deeply forked.

**Distribution** : India : Northern India from Punjab to West Bengal and Assam.

**Elsewhere** : Pakistan : Indus plain and adjacent hilly areas and Bangladesh.

**Remarks** : Elegant fine fish. It is an important major carp of India and a game fish. It has been successfully transplanted into water of peninsular India for aquaculture.

***Cirrhinius reba* (Hamilton-Buchanan) \***

1822. *Cyprinus reba* Hamilton-Buchanan, *Fishes of Ganges* : 280, 386. (Type-locality: rivers and ponds of Bengal and Bihar).

1877. *Cirrhina reba* Day, *Fishes of India* : 549, pl. 130, fig. 3; Day, 1889, *Fauna Br. India*, Fishes, 1 : 279, fig. 96.

**Diagnostic characters** : Body elongate, snout projecting beyond mouth. Mouth broad with one pair of short rostral barbels.

**Distribution** : India,

**Elsewhere** : Pakistan, Nepal and Bangladesh.

**Remarks** : Plankton and detritus feeder. Fast growing fish.

**Genus *Labeo* Cuvier**

***Labeo bata* (Hamilton-Buchanan) \***

1822. *Cyprinus bata* Hamilton-Buchanan, *Fishes of Ganges* : 283, 386. (Type-locality: rivers and ponds of Bengal).

1877. *Labeo bata* Day, *Fishes of India*: 542, pl. 129, fig. 5; Day, 1889, *Fauna Br. India*, Fishes, 1 : 268; Murthy, 1977, *Proc. Indian Acad. Sci.*, **85 B** (3) : 134.

**Diagnostic characters** : Body elongate, snout slightly projecting beyond mouth, eyes large, mouth with continuous thin lips, a tubercle inside lower jaw above symphysis. Barbels a pair of minute maxillary only. Dorsal fin nearer snout tip than base of caudal fin. Pectorals as long as head, extending to pelvic fins.

**Distribution** : India : Cauvery, Krishna and Godavari river systems in South India, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal and Assam.

**Elsewhere** : Bangladesh and Nepal.

**Remarks** : A minor carp cultivated with the Indian major carps in India. It is extensively used for stocking tanks in several parts of India. A tasty food fish.

***Labeo boggut* (Sykes)**

1838. *Chondrostoma boggut* Sykes, *Proc. zool. Soc. Lond.*, **6** : 160. (Type-locality : Poona waterways, Maharashtra).

1877. *Labeo boggut* Day, *Fishes of India* : 542; pl. 127, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 269.

*Diagnostic characters* : Body slender and elongate, eyes moderate not visible from underside of head, mouth moderate, lips thick, lower lip fimbriated with a horny covering inside, snout thick with few tubercles and a pair of short maxillary barbels. Dorsal fin inserted nearer to snout tip than to base of caudal fin. Pectoral fin as long as head not extending to pelvic fins. Caudal fin forked deeply. Scales small.

*Distribution* : India : Northern India and upto Cauvery river system.

*Elsewhere* : Pakistan and Bangladesh.

*Remarks* : A slender fish. It is also used for stocking ponds and has good prospects of exploitation.

#### *Labeo calbasu* (Hamilton-Buchanan) \*

1822. *Cyprinus calbasu* Hamilton-Buchanan, *Fishes of Ganges* : 297, 387, pl. 2, fig. 33. (Type-locality: rivers and ponds of Bengal and in the western provinces).

1877. *Labeo calbsu* Day, *Fishes of India*, 536, pl. 126, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 259, fig. 93; Hora, 1921, *Rec. Indian Mus.*, 22(3) : 182; Macdonald, 1948, *J. Bombay nat. Hist. Soc.*, 44 : 529, fig. 10.

*Diagnostic characters* : Body stout, head fairly large, conical, mouth narrow, snout depressed pointed and without lateral lobe, barbels two pairs. Dorsal fin with a fairly long base, inserted midway between snout tip and base of deeply forked caudal fin. Scales moderate, blackish or metallic grey all over the body, fins black.

*Distribution* : India.

*Elsewhere* : Pakistan, Bangladesh, Myanmar, Thailand and Yunan (South China).

*Remarks* : It is mainly a bottom feeder. An important food and game fish.

#### *Labeo fimbriatus* (Bloch) \*\*

1795. *Cyprinus fimbriatus* Bloch, *Naturgesch ausland Fische*, 12 : 50, pl. 409. (Type-locality : Malabarischen Kueste= Madras).

1877. *Labeo fimbriatus* Day, *Fishes of India* : 536, pl. 126, fig. 3; Day, 1889, *Fauna Br. India*, Fishes, 1 : 258; Murthy, 1977. *Proc. Indian Acad. Sci.*, 85 B (3) : 137, pl. 4, fig. 3.

*Diagnostic characters* : Body elongate, snout blunt, overhung, swollen and beset with pores, barbels two short pairs. Dorsal fin inserted nearer to snout-tip than to base of caudal fin. Pectoral fins nearly as long as head. Caudal fin deeply forked. Dorsal pectoral and caudal fins dark, anal and pelvic fins black.

*Distribution* : India : West Bengal and Eastern Ghats.

*Elsewhere* : Pakistan, Nepal and Myanmar.

*Remarks* : Predominantly an herbivore, feeding on diatoms, blue-green and green algae, higher aquatic vegetation, insects and decayed organic matter. New record from Pichhola Lake.

***Labeo gonius* (Hamilton-Buchanan) \***

1822. *Cyprinus gonius* Hamilton-Buchanan, *Fishes of Ganges*: 292, 387, pl. 4, fig. 82. (Type-locality: freshwater rivers and ponds of Bengal).

1877. *Labeo gonius* Day, *Fishes of India*: 537. pl. 127, fig. 1; Day, 1889, *Fauna Br. India*, Fishes, 1 : 261; Shaw and Shebbeare, 1937, *J. Asiat. Soc. Beng.*, 3 : 53, pl. 2, fig. 2 and text-fig. 51.

*Diagnostic characters* : Body elongate, snout projecting slightly beyond mouth with distinct pores without lateral lobe. Mouth narrow with lips thick and fringed, barbels short, two pairs. Caudal fin deeply forked with pointed lobes. Scales small greenish black dorsally and dull white on the sides and below.

*Distribution* : India : Northern India.

*Elsewhere* : Pakistan, Bangladesh and Myanmar.

*Remarks* : Predominantly an herbivore, feeding on diatoms, blue-green and green algae, higher aquatic vegetation, insects and decayed organic matter.

***Labeo rohita* (Hamilton-Buchanan) \***

1822. *Cyprinus rohita* Hamilton-Buchanan, *Fishes of Ganges*: 301, 388, pl. 36, fig. 85. (Type-locality: Freshwater rivers of gangetic provinces).

1877. *Labeo rohita* Day, *Fishes of India*: 538. pl. 127, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 262; Macdonald, 1948, *J. Bombay nat. Hist. Soc.*, 44 : 527, fig. 9.

1924. *Labeo horai* Fowler, *Proc. Acad. nat. Sci. Philad.*, 76 : 95, fig 8 (Type-locality: Sutlej river nr. Ludhiana, Punjab).

*Diagnostic characters* : Body moderately elongate, snout obtuse, depressed, without labial lobe. Eyes large, mouth small, lips thick and fringed with thin very short maxillary pair of barbels. Dorsal fin present in between tip of snout and base of deeply forked caudal fin. Scales moderate, reddish blue on the back, silvery sides.

*Distribution* : India : North and central India.

*Elsewhere* : Pakistan, Bangladesh, Terai region of Nepal and Myanmar.

*Remarks* : Graceful riverine fish. A bottom feeder and prefers to feed on plant matter including decaying vegetation. An excellent game fish.

Genus *Puntius* Hamilton-Buchanan*Puntius chola* (Hamilton-Buchanan)

1822. *Cyprinus chola* Hamilton-Buchanan, *Fishes of Ganges*, 312, 289. (Type-locality: Northeastern parts of Bengal).

1878. *Barbus chola* Day, *Fishes of India*, 571, pl. 142, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 317.

1937. *Barbus titius* (Hamilton-Buchanan) Shaw and Shebbeare, *J. roy. Asiat. Soc. Beng. (Sci)*, 3 : 44, fig. 39 and pl. 5, fig. 5, Hora and Gupta, 1940, *J. roy. Asiat. Soc. Beng. (Sci.)*, 6 (2) : 82.

**Diagnostic characters** : Body deep and compressed, mouth moderate with a pair of snout maxillary barbels. Dorsal fin present midway between snout-tip and base of caudal fin, but undivided dorsal fin ray osseous and smooth, complete lateral line. Scales moderate, a dark blotch between 23<sup>rd</sup> and 25<sup>th</sup> scales.

**Distribution** : India,

**Elsewhere** : Pakistan, Nepal, Bangladesh, Sri Lanka and Myanmar.

**Remarks** : Oil is extracted from this fish in Myanmar.

*Puntius sarana sarana* (Hamilton-Buchanan) \*

1822. *Cyprinus sarana* Hamilton-Buchanan, *Fishes of Ganges*, 307, 388. (Type-locality: ponds and rivers of Bengal).

1878. *Barbus sarana* Day, *Fishes of India*, 560, pl. 136, fig. 2; Day, 1889, *Fauna Br. India*, Fishes, 1 : 300.

1981. *Puntius saberi* Datta and Karmakar, *Bull. zool. Surv. India*, 3(3) : 179, fig. 1. (Type-locality: Cherogaru Talao, Bastar Dist., MP).

**Diagnostic characters** : Body elongate, head small with moderate eyes. Mouth with two pairs of barbels, rostral ones as long as orbit, maxillary pair much longer. Dorsal fin inserted slightly nearer to tip of snout than to base of caudal fin. Colour in life black olive, cheeks golden.

**Distribution** : India : Throughout except peninsular India south of Krishna river.

**Elsewhere** : Afghanistan, Pakistan, Nepal, Bangladesh and Bhutan.

**Remarks** : Common food fish.

*Puntius sophore* (Hamilton-Buchanan) \*

1822. *Cyprinus sophore* Hamilton-Buchanan, *Fishes of Ganges* : 310, 389. (nec pl. 19, fig. 86). (Type-locality: rivers in Gangetic provinces); Chaudhuri, 1916, *Mem. Indian Mus.*, 5 : 436.

1878. *Barbus sophore* Day, *Fishes of India* : 566, pl. 143, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 309; Murthy, 1977, *Proc. Indian Acad. Sci.*, 85 (B) (3) : 126.
1924. *Barbus annandalei* Fowler, *Proc. Acad. Nat. Sci. Philad*, 76 : 87, fig. 6. (Type-locality: Sutlej river at Ludhiana); Chaudhuri, 1916, *Mem. Indian Mus.*, 5 : 436.
1970. *Puntius carletoni* Tilak, *Sci and Cult.*, 36 (11) : 613, fig. 1.

**Diagnostic characters** : Body relatively deep, dorsal more convex than ventral, lateral line incomplete. Head short with terminal mouth, barbels absent. Dorsal fin present equidistant between tip of snout and base of caudal fin, its last un-branched ray osseous and smooth. Scales moderate, dark greenish back, lower half silvery, a deep black round block at base of caudal fin.

**Distribution** : India.

**Elsewhere** : Pakistan, Nepal, Bangladesh, Myanmar and Yuanan (China).

**Remarks** : Shoal fish and of medicinal value.

#### ***Puntius ticto* (Hamilton-Buchanan)\***

1822. *Cyprinus ticto* Hamilton-Buchanan, *Fishes of Ganges* : 314, 398, pl. 8, fig. 87. (Type-locality: South-eastern parts of Bengal); Murthy, 1977, *Proc. Indian Acad. Sci.*, 85 B (3) : 130.
1865. *Puntius punctatus* Day, *Proc. zool. soc. Lond.* : 302. (Type-locality: Cochin); Hora, Misra and Malik, 1939, *Rec. Indian Mus.*, 41 (3) : 263.
1878. *Barbus ticto* Day, *Fishes of India* : 576, pl. 144, fig. 7; Day, 1889, *Fauna Br. India*, Fishes, 1 : 325; Hora and Misra, 1938, *J. Bombay nat. Hist. Soc.*, 40 (1) : 28, fig. 3.

**Diagnostic characters** : Body elongate, head strongly compressed and elevated back, dorsal fin ray strong and osseous, mouth terminal and small, barbels absent. Dorsal fin posterior to pelvic fin, its last un-branched ray osseous and strong lateral line incomplete. Scales medium, black grey to grassy green, silvery sides with two lateral spots.

**Distribution** : India.

**Elsewhere** : Pakistan, Nepal, Sri Lanka, Bangladesh, Myanmar and Thailand.

**Remarks** : Popular aquarium fish.

#### Genus ***Tor*** Gray

#### ***Tor khudree* (Sykes) \***

1839. *Barbus khudree* Sykes, *Trans. zool. Soc. Lond.*, 2 : 357. (Type-locality: Mulla Mutha river nr. Poona, Maharashtra); Hora, 1938, *J. Bombay nat. Hist., Soc.*, 49 (1) : 25.
1943. *Barbus (Tor) khudree* Hora, *J. Bombay nat. Hist. Soc.*, 44(1) : 6.

1953. *Tor mosal mahanadicus* David, 1953, *J. zool. Soc. India*, 5(2) : 245. (Type-locality: Mahanadi river at Hirakud, Orissa).

1982. *Tor khudree longispinnis* (Gunther) Sen and Jayaram. 1982. *Rec zool. Surv. India Occ. Paper*, (39) : 13.

*Diagnostic characters* : Body elongate, eyes small, mouth moderate with fleshy lips and two equal pairs of barbels. Scales large, pectoral fins shorter than head. Lateral side of snout covered with a pair of small indistinct tubercles.

*Distribution* : India : Madhya Pradesh, Deccan and entire peninsular India.

*Elsewhere* : Sri Lanka.

*Remarks* : An important angling and food fish.

Subfamily CULTRINAE

Genus *Chela* Hamilton-Buchanan

*Chela cachi* (Hamilton-Buchanan)

1822. *Cyprinus (Chela) cachi* Hamilton-Buchanan, *Fishes of Ganges* : 259, 384. (Type-locality: Ganges river about commencement of delta).

1878. *Perilampus atpar* (Hamilton-Buchanan) Day, *Fishes of India* : 598, pl. 151, fig. 6; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 359.

1958. *Chela (Chela) cachi* Silas, *J. Bombay nat. Hist. Soc.*, 55(1) : 66, fig.2a.

*Diagnostic characters* : Body greatly compressed, mouth slightly oblique, outer ray of pelvic fin strongly produced, filamentous extending up to third of anal fin.

*Distribution* : India.

*Elsewhere* : Pakistan, Bangladesh and Myanmar.

*Remarks* : Important aquarium fish. Also used as a larvicidal fish and bait for mashseer, channa and other carnivorous fishes.

*Chela laubu* (Hamilton-Buchanan)\*

1822. *Cyprinus (Chela) laubu* Hamilton-Buchanan, *Fishes of Ganges*: 260, 384. (Type-locality: ponds in northern parts of Bengal).

1878. *Perilampus laubu*, *Fishes of India* : 598, pl. 151, fig. 5; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 360, fig. 112.

1895. *Danio (Danio) menoni* Barman, *J. Bombay nat. Hist. Soc.*, 82(3) : 602, fig. (Type-locality: Mosampat, Andhra Pradesh); Tilak and Jain, 1987, *J. Bombay nat. Hist. Soc.*, 84(3) : 693.

*Diagnostic characters* : Body deep and greatly compressed, abdomen keeled only between and behind pelvic fins. Mouth slightly oblique. Pectoral fins large and wing like, outer pelvic fin ray strongly produced. Lateral line complete.

*Distribution* : India.

*Elsewhere* : Pakistan, Bangladesh, Sri Lanka, Myanmar, Malay Peninsula and Sumatra.

*Remarks* : Used as larvicidal fish. An aquarium fish. Very beautiful shoaling fish.

### Genus *Securicula* Gunther

#### *Securicula* sp.

1868. *Securicula* Gunther, *Cat. Fishes Br. Mus.*, 7 : 332. (Type-species: *Cyprinus gora* Hamilton-Buchanan); Howes, 1979, *Bull. Br. Mus, nat. Hist. (Zool.)*, 36(3) : 191.

1967. *Pseudooxygaster* Banareescu, *Revue roum. Biol. (Zool.)*, 12(5) : 306. (Type-species: *Cyprinus gora* Hamilton-Buchanan); Mirza, 1975, *Biologia*, 16(2) : 92.

*Diagnostic characters* : Body elongate and compressed, abdomen without scales with a sharp keel. Head compressed, mouth oblique, almost vertical. Dorsal fin short, rays 10. Pectoral fins low and pointed. Caudal fin deeply forked. Scales very small.

*Distribution* : The genus is confined to northern and eastern India.

*Elsewhere* : Pakistan and Bangladesh.

*Remarks* : Only one species *S. gora* is found in India in tanks, jheels, canals and rivers. It is not of much importance to fisheries.

### Subfamily RASBORINAE

#### Genus *Amblypharyngodon* Bleeker

#### *Amblypharyngodon mola* (Hamilton-Buchanan)

1822. *Cyprinus mola* Hamilton-Buchanan, *Fishes of Ganges* : 334, 392, pl. 38; fig. 92 (Type-locality: ponds and rivers of Gangetic provinces).

1878. *Amblypharyngodon mola* Day, *Fishes of India* : 555, pl. 135, fig. 4; Day, 1889, *Fauna Br. India, Fishes*, 1 : 291, fig. 101.

1912. *Amblypharyngodon saranensis* Chaudhuri, *Rec. Indian Mus.*, 7 : 440, pl. 39, fig. 2 (Type-locality: Jharia river at Saran, Bihar).

1975. *Amblypharyngodon gadigarhi* Malhotra and Singh Dutta, *Proc. nat. Acad. Sci. India*, 45(B)(3) : 154, fig. 1. (Type-locality : Gadigarh, Jammu).

*Diagnostic characters* : Body elongate, eyes large. Pectoral fins reaching ventrals, dorsal fins originate half in advance of anal. Scales small with a deep grayish silvery incomplete lateral line.

*Distribution* : India : Throughout the country (except Kerala).

*Elsewhere* : Pakistan, Bangladesh and Myanmar.

*Remarks* : Not of much importance to fisheries.

#### Genus *Barilius* Hamilton-Buchanan

#### *Barilius barna* (Hamilton-Buchanan)

1822. *Cyprinus (Barilius) barna* Hamilton-Buchanan, *Fishes of Ganges* : 268, 384. (Type-locality: Yamuna river and Brahmaputra river).
1878. *Barilius barna* Day, *Fishes of India* : 592, pl. 148, fig.1 and 2; Day, 1889, *Fauna Br. India*, Fishes, 1: 350.
1985. *Barilius jayarami* Barman, *J. Bombay nat. Hist. Soc.*, **82**(1) : 170, fig.1 (Type-locality: Namdapha wildlife sanctuary, Arunachal Pradesh):

*Diagnostic Characters* : Body deep, mouth moderate with short jaws and barbels absent. Dorsal fin inserted in advance of anal fin, its last fin ray extending almost to base of caudal fin. Scales moderate, tubercles large and well developed on snout and lower jaw.

*Distribution* : India : Ganga and Brahmaputra river systems and Orissa (Mahanadi).

*Elsewhere* : Nepal, Bangladesh and Myanmar.

*Remarks* : Voracious fish of little importance to fisheries.

#### *Barilius bendelisis* (Hamilton-Buchanan)

1807. *Cyprinus bendelisis* Hamilton-Buchanan, *Journey in Mysore*, **3** : 345, pl. 32. (Type-locality: Vedawati stream, headwaters of Krishna river nr. Heriuru, Mysore).
1878. *Barilius bendelisis* Day, *Fishes of India* : 590, pl. 148, fig. 7, 8 and 9; Day, 1889, *Fauna Br. India*, Fishes, **1** : 347; Howes, 1980, *Bull. Br. Mus. Nat. Hist. (Zool)*, **37** (3) : 189; Tilak *et al.*, 1984, *Rec. zool. Surv. India*, **81** (3/4) : 280, figs 1 & 2.
1986. *Barilius howesi* Barman, *J. Bombay nat. Hist. Soc.*, **83** (1) : 171, fig. 1. (Type-locality: Salkapara, Jalpaiguri Dist., West Bengal).

*Diagnostic characters* : Body shallow, mouth moderate, jaws long, maxilla reaches to anterior third of eye, barbels two short pairs, pores on snout and lower jaw. Dorsal fin present entirely in advance of anal fin, nearer to base of caudal fin than to snout-tip.

Scales moderate size, with many radii, each with a distinct black spot, fins tinged with orange.

*Distribution* : India,

*Elsewhere* : Pakistan, Nepal, Bangladesh and Sri Lanka.

*Remarks* : A commercial fish.

### Genus *Brachydanio* Weber and de Beaufort

#### *Brachydanio rerio* (Hamilton-Buchanan)

1822. *Cyprinus rerio* Hamilton-Buchanan, *Fishes of Ganges* : 323, 390. (Type-locality: Kosi river, Uttar Pradesh).

1878. *Danio rerio* Day, *Fishes of India* : 597, pl. 151, fig. 4; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 385.

*Diagnostic characters* : Body elongate, slim, mouth small, obliquely upwards with two pairs of well developed barbels, the maxillary pair reaches beyond half of pectoral fin. Caudal fin forked. Lateral line generally absent, often rudimentary or incomplete in which case it extends to base of pelvic fin.

*Distribution* : India : Eastern parts from West Bengal to Krishna river system.

*Elsewhere* : Pakistan, Bangladesh and Nepal.

*Remarks* : Most popular aquarium fish being extremely active and graceful.

### Genus *Rasbora* Bleeker

#### *Rasbora rasbora* (Hamilton-Buchanan) \*

1822. *Cyprinus rasbora* Hamilton-Buchanan, *Fishess of Ganges* : 329, 391, pl. 2, fig. 90. (Type-locality: ponds of Bengal).

1878. *Rasbora buchanani* Bleeker Day, *Fishes of India* : 584, pl. 145, fig. 10; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 337, fig. 107.

1913. *Rasbora rasbora* var. *kobonensis* Chaudhuri, *Rec. Indian Mus.*, 8(3) : 251, pl. 8, figs. 1, 1a, 1b (Type-locality: Brahmaputra, river at Kabo, Abor Hills, Assam).

*Diagnostic characters* : Body elongate. Mouth moderate, obliquely directed upwards. Dorsal fin inserted behind origin of pelvic fins. Caudal fin deeply emarginated. Lateral line complete. Colour in life olive-brown. Caudal fin with sharply defined black hind margin.

*Distribution* : India : Gangetic provinces and Assam.

*Elsewhere* : Pakistan, Bangladesh, Myanmar and Thailand.

*Remarks* : A popular aquaria fish especially for small aquarium.

Subfamily GARNINAE

Genus *Garna* Hamilton-Buchanan

*Garra gotyla gotyla* (Gray)

1832. *Cyprinus gotyla* Gray. *Illustr. Indian Zool.*, 1 : pl. 88, figs 3, 3a, (Type-locality : Northern India); Hora, 1921, *Rec. Indian Mus.*, 22(5) : 653.

1964. *Garra gotyla gotyla* Menon, *Mem. India Mus.*, 14(4) : 233, pl. 13, figs. 1-4.

*Diagnostic characters* : Body elongate, head depressed, snout with a well-developed median proboscis and a transverse lobe at tip, Mouth arched, with two pairs of barbels. Dorsal fin present near tip of snout than to caudal fin base. Pectoral fin equal to or considerably shorter than head length.

*Distribution* : India : All along the Himalaya, Chota-Nagpur plateau and the Vindhya Satpura mountains of the Indian peninsula.

*Elsewhere* : Pakistan, Bangladesh and upper Myanmar.

*Remarks* : Valuable food fish.

Family BALITORIDAE

Sufamily NEMACECILINAE

Genus *Nemacheilus* Bleeker

*Nemachelius botia* (Hamilton-Buchanan)

1822. *Cobitis botia* Hamilton-Buchanan, *Fishes of Ganges* : 350, 394. (Type-locality : rivers of north-eastern Bengal).

1878. *Nemacheilus botia* Day (Partim), 1878, *Fishes of India* : 614, pl. 156, fig. 5.

1910. *Nemachilus mackenziei* Chaudhuri, *Rec. Indian Mus.*, 5(3) : 183 (Type-locality: Cheriadhang and Toulasal in Nainital dist., U.P.; nr. Siripur in Bengal; and Purnahia in Champaran Dist., Bihar).

1987. *Nemacheilus botia* Menon, *Fauna of India, Pisces*, 4 : 141, pl. 5, fig. 5. Indus basin.

*Diagnostic characters* : Body slender, eyes moderate, nostrils close together, anterior not tubular. Mouth semi-circular lips fleshy with well developed barbels. Dorsal fin present near snout tip than base of caudal fin. Caudal fin slightly emarginate. Scales

conspicuous and imbricate, lateral line casually complete, ending beyond base of anal fin, olivaceous to yellowish orange colour with 12-16 blackish crossbands.

*Distribution* : India : Northern India-Brahmaputra and Ganga basin.

*Elsewhere* : Pakistan.

*Remarks* : Not of any interest to fisheries.

Family COBITIDAE  
Sufamily COBITINAE

Genus *Lepidocephalus* Bleeker

*Lepidocephalus guntea* (Hamilton-Buchanan) \*

1822. *Cobitis guntea* Hamilton-Buchanan, *Fishes of Ganges* : 353, 394. (Type-locality : Bengal).

1948. *Lepidocephalus guntea birmanicus* Rendahl, *Ark. Zool.*, **40A**(2) : 108. (Type-locality : Burma and Thailand); Banarescu and Nalbant, 1968, *Mitt. Hamburg zool. Mus. Inst.*, **65** : 345, pl. 2, fig. 21 (Ganges drainage).

1975. *Lepidocephalus dibruensis* Sen, 1979, *Bull. Zool. Surv. India*, **2** (1) : 35, fig. 1. (Type-locality: Dibru river at Guijan., Assam).

1981. *Lepidocephalus (Lepidocephalus) guntea* Tilak and Husain, *Occ. Paper, Rec. zool. Surv. India*, **32** : 7, figs 1-4.

*Diagnostic characters* : Body elongate, slightly compressed anteriorly and strong posteriorly. Mouth inferior with three pairs of barbels. Dorsal fin present slightly behind level of origin of pelvic fins, nearer to caudal fin base than to snout tip. Caudal fin convex with round corners. Scales very small, imbricate, scales on head in patches below and behind eyes. A dark medium broad line composed of black spots, stretching from gill to caudal fin base present.

*Distribution* : India : Northern India.

*Elsewhere* : Pakistan, Bangladesh, Nepal, Myanmar and Thailand.

*Remarks* : An aquarium fish.

Sufamily BOTIINAE

Genus *Botia* Gray

*Botia lohachata* Chaudhuri

1912. *Botia lohachata* Chaudhuri *Rec. Indian Mus.*, **7** (5) : 441, pl. 40, figs. 2, 2a, 2b. (Type-locality : Sandak river at Saran, Bihar); Sterba, 1963, *Freshwater fishes of the World*: 347, fig, 493; Yazdani, 1980, *J. Bombay nat. Hist. Soc.*, **77** (2) : 152.

*Diagnostic characters* : Body elongate and compressed, head depressed, Mouth terminal, 4 pairs of barbels-maxillary barbels extend posteriorly to anal fin. Dorsal spine smooth, caudal fin forked with upper lobe longer, two light longitudinal bands along the lateral line a dark shoulder spot present generally.

*Distribution* : India : Ganga drainage.

*Elsewhere* : Pakistan, Bangladesh and Nepal.

*Remarks* : An aquarium fish.

Order SILURIFORMES

Family BAGRIDAE

Genus *Aorichthys* Wu

*Aorichthys aor* (Hamilton-Buchanan) \*\*

1822. *Pimelodus aor* Hamilton-Buchanan, *Fishes of Ganges* : 205, 379, pl. 20, fig. 68. (Type-locality: rivers of Bengal and upper parts of Gangetic estuary).

1877. *Macrones aor* Day, *Fishes of India* : 444; Day, 1889, *Fauna Br. India*, Fishes, 1 : 149.

1976. *Mystus (Aorichthys) aor* Misra, *Fauna of India*, Pisces. (2<sup>nd</sup> ed.), 3 : 74.

*Diagnostic characters* : Body graceful, elongate and compressed. Snout broad and rounded. Mouth subterminal and wide with four pairs of barbels, the maxillary pair extends to base of caudal fin. Dorsal spine serrated. Adipose fin long.

*Distribution* : India : Northern India up to the Krishna river system in the south.

*Elsewhere* : Pakistan, Nepal, Bangladesh and Upper Burma.

*Remarks* : Of considerable fishery value.

*Aorichthys seenghala* (Sykes) \*

1841. *Platystoma seenghala* Sykes, *Trans. Zool. Soc. Lond.*, 2 : 371, pl. 65, fig. 2 (Type-locality: Mulla Motha river at Poona).

1877. *Macrones seenghala* Day, *Fishes of India*: 444, pl. 99, fig. 1; Day, 1889, *Fauna Br. India*, fishes, 1 : 150.

1976. *Mystus (Aorichthys) seenghala* Mirsa, *Fauna of India*, Pisces (2<sup>nd</sup> ed.), 3 : 79, fig. 16.

*Diagnostic characters* : Body graceful, elongate and compressed. Snout broad and spatulate. Mouth subterminal, barbels four pairs. Dorsal spine weakly serrated on its posterior margin, adipose fin base short, about as long as rayed dorsal fin.

*Distribution* : India : Ganga, Yamuna, Krishna, Godavari and Cauvery river systems.

*Elsewhere* : Afghanistan, Pakistan, Nepal and Bangladesh.

*Remarks* : A good sports fish.

### Genus *Mystus* Scopoli

#### *Mystus bleekeri* (Day) \*

1846. *Bagrus keletius* (nec. Valenciennes) Bleeker, *Nat. Geneesk. Arch. Ned. Indie*, (2) 3 : 135. (Type-locality: Bengal).

1910. *Mystus bleekeri* var. *burmanicus* Jenkins, *Rec. Indian Mus.*, 5 (2) : 138. (Type-locality: Bhamo, Burma).

1976. *Mystus (Mystus) bleekeri* Misra, *Fauna of India*, Pisces (2<sup>nd</sup> ed.), 3 : 84, fig. 17.

1977. *Mystus bleekeri* Jayaram, *Rec. zool. Surv. India, Occ. Pap. No.*, 8 : 29, fig. 21B.

*Diagnostic characters* : Body elongate and compressed, head pressed mouth terminal, 4 pairs of barbels-maxillary barbels extend posteriorly to anal fin. Dorsal spine smooth, caudal fin forked with upper lobe longer, two light longitudinal bands along the lateral line a dark shoulder spot present generally.

*Distribution* : India : Generally confined to northern India, the southernmost limit being the Mahanadi headwaters.

*Elsewhere* : Pakistan, Bangladesh, Nepal, Myanmar and Sumatra.

*Remarks* : Not of much fishery importance.

#### *Mystus cavasius* (Hamilton-Buchanan) \*

1822. *Pimelodus cavasius* Hamilton-Buchanan, *Fishes of Ganges* : 203, 379, pl. 11, fig. 67. (Type-locality : Gangetic provinces).

1976. *Mystus (Mystus) cavasius* Misra, *Fauna of India* Pisces (2<sup>nd</sup> ed.), 3 : 87, fig. 18.

1977. *Mystus cavasius* Jayaram, *Rec. zool. Surv. India, Occ. Pap. No.*, 8 : 29, fig. 21 A.

*Diagnostic characters* : Body elongate and compressed, head conical, mouth terminal, upper jaw longer, barbel four pairs, maxillary pair extending beyond caudal base, pectoral spine serrated, adipose dorsal fin long dorsally leaden, a black shoulder spot and a dark blotch at the base of dorsal fin, yellowish abdomen.

*Distribution* : India.

*Elsewhere* : Pakistan, Sri Lanka, Nepal, Bangladesh, Myanmar and Thailand.

*Remarks* : Very common food fish of India.

## Family SILURIDAE

Genus *Ompok* Lacepede*Ompok bimaculatus* (Bloch) \*

1797. *Silurus bimaculatus* Bloch, *Ichthyol. Hist. Nat. des. Poiss.*, 11 : 17, pl. 364. (Type-locality: Malabar).

1976. *Ompok bimaculatus* Misra, *Fauna of India, Pisces* (2<sup>nd</sup> ed.), 3 : 189, fig. 35.

1976. *Ompok canio* (Hamilton-Buchanan) Misra, 1976, *Fauna of India, Pisces* (2<sup>nd</sup> ed.), 3 : 192; Coad, 1981, *Nat. Mus. Nat. Sci. Ottawa*, (14) : 15.

1976. *Ompok sindensis* Misra, *Fauna of India, Pisces* (2<sup>nd</sup> ed.), 3 : 198.

*Diagnostic characters* : Body elongate and compressed, eyes medium sized, mouth large and oblique, two pairs of barbels, maxillary pair longer than head, a short dorsal without spine, anal rays long continuous, pectoral spine moderately strong serrated on its inner edge. Caudal fin deeply forked with pointed lobes.

*Distribution* : India.

*Elsewhere* : Afghanistan, Pakistan, Sri Lanka, Bangladesh, Myanmar, Thailand, Java, Sumatra, Borneo and China.

*Remarks* : A very tasty fish and is high priced. Young fishes are transparent as glass.

Genus *Wallago* Bleeker*Wallago attu* (Schneider) \*

1801. *Silurus attu* Schneider, *Syst. Ichth.*, : 378, pl. 75 (Type-locality: Malabar).

1877. *Wallago attu* Day, *Fishes of India* : 479, pl. III, fig. 4; Day, 1889, *Fauna Br. India, Fishes*, 1 : 11126, fig. 54; Misra, 1976. *Fauna of India, Pisces* (2<sup>nd</sup> ed.), 3 : 206, fig. 41.

1939. *Wallagonia attu* Hora, *J. Bombay nat. Hist. Soc.*, 41 (1) : 64, pl.

1953. *Wallagu attu valeya* Deraniyagala, *Spolia zeylan.*, 27 : 15 (Type-locality : Yakvala, Ceylon); Roberts, 1982, *Coperia*, (4): 891.

*Diagnostic characters* : Body elongate and compressed, eyes small. Mouth wide barbels, two pairs, maxillary pair long dorsal fin short, inserted usually slightly in advance of pelvic fins. Caudal fin deeply forked, its upper lobe longer uniform silvery, dorsally greyish green with a wash of gold and cream.

*Distribution* : India.

*Elsewhere* : Pakistan, Sri Lanka, Nepal, Bangladesh, Myanmar, Thailand, Vietnam, Kampuchea, Sumatra and Java.

*Remarks* : One of the largest, voracious and predatory catfishes. Esteemed food of poorer classes. It is also a good sport fish. It is sluggish in nature and stays at bottom of water in search of food. Due to its rich oil content many like it. The Hindus also offer it to Goddess Kali.

Family CLARIIDAE

Genus *Clarias* Scopoli

*Clarias* sp.

1777. *Clarias* Scopoli, *Introductio ad Historiam Naturalem*: 455 (Type-species : *Silurus anguillaris* Linnaeus); Teugels and Roberts, 1987, *Zool. J. Linn. Soc.*, 90 : 95 (Type-species designated); Hora, 1936, *Rec. Indian Mus.*, 38 (3) : 347-350.

*Diagnostic characters* : Body elongate and compressed. Head moderately depressed. Eyes small not visible from underside of head. Dorsal and anal fins long. Pectoral and Pelvic fins well-developed. Lateral line distinct.

*Remarks* : Three species are found in India and only *C. batrachus* is widely distributed. It is abundant and esteemed for its nourishing properties.

Family HETEROPNEUSTIDAE

Genus *Heteropneustes* Muller

*Heteropneustes fossilis* (Bloch)

1794. *Silurus fossilis* Bloch, *Naturgesch. aust. Fische*, 8 : 46, pl. 370, fig. 2. (Type-locality: Tranquebar, Tamil Nadu).

1976. *Heteropneustes fossilis* Misra, 1976, *Fauna of India, Pisces* (2<sup>nd</sup> ed.), 3 : 135, fig. 24.

*Diagnostic characters* : Body elongate, compressed behind, wide flathead, four pairs of barbels, wide gill-opening, dorsal fin short, present above tip of pectoral fins. Pectoral fin with a strong spine, serrated along its inner edge. Anal fin long-based, separated by a distinct notch from caudal fin.

*Distribution* : India : Throughout including the Andaman Islands.

*Elsewhere* : Pakistan, Nepal, Bangladesh, Sri Lanka, Myanmar, Thailand and Laos.

*Remarks* : A fish of high economic importance. It lives in large shoals and is extensively fished on account of the reported invigorating qualities of its flesh. The fish is much dreaded because of its aggressive behavior and can inflict painful wounds with its potentially dangerous pectoral spines.

Order CYPRINODONTIFORMES

Family BELONIDAE

Genus *Xenentodon* Regan

*Xenentodon cancila* (Hamilton-Buchanan)

1822. *Esox cancila* Hamilton-Buchanan, *Fishes of Ganges* : 213, 380, pl. 27, fig. 70. (Type-locality: Gangetic provinces).

1877. *Belone cancila* Day, *Fishes of India*, *Fishes* : 511, pl. 118, fig. 5; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 420, fig. 136.

*Diagnostic characters* : Body very elongate and slightly compressed. Eyes small, dorsal and anal fins similar looking. Caudal fin truncate greenish grey above, whitish along the abdomen, upper part of body base with black spots.

*Distribution* : India,

*Elsewhere* : Pakistan, Bangladesh, Sri Lanka, Myanmar and Thailand.

*Remarks* : An elegant surface living fish.

Order PERCIFORMES

Family AMBASSIDAE

Genus *Chanda* Hamilton-Buchanan

*Chanda nama* Hamilton-Buchanan

1822. *Chanda nama* Hamilton-Buchanan, *Fishes of Ganges* : 109, 371, pl. 39, fig. 37. (Type-locality: ponds throughout Bengal).

1875. *Ambassius nama* Day, *Fishes of India* : 50, pl. 14, fig. 5; Day, 1889, *Fauna Br. India*, *Fishes*, 1 : 484, fig. 149.

*Diagnostic characters* : Body ovate and strongly compressed. Mouth large. Scales minute irregularly arranged. Colour in life transparent, silvery-yellowish with a silvery longitudinal band along the flank.

*Distribution* : India,

*Elsewhere* : Pakistan, Nepal, Bangladesh and Myanmar.

*Remarks* : A low priced fish preferred by many. It could be effectively used in control of guinea worms and also for malaria control.

## Family CHANNIDAE

Genus *Channa* Scopoli*Channa marulius* (Hamilton-Buchanan) \*

1822. *Ophiocephalus marulius* Hamilton-Buchanan, *Fishes of Ganges*: 65, 367, pl. 17, fig. 19. (Type-locality: Gangetic provinces); Day, 1876, *Fishes of India* : 363, pl. 76, fig. 4; Day, 1889, *Fauna Br. India*, *Fishes*, 2 : 360.

1945. *Channa marulius ara* Deraniyagala, *Spolia Zeyl.*, 24 : 93, pl. 24. (Type-locality : Ceylon).

*Diagnostic characters* : Body elongate and fairly rounded, eyes moderate, mouth large, pectoral fins about half head length, caudal lighter below, young ones conspicuous with a brilliant orange coloured lateral band, 4 to 5 roundish black blotches on the middle of the body below the lateral line.

*Distribution* : India,

*Elsewhere* : Pakistan, Sri Lanka, Bangladesh, Nepal, Myanmar, Thailand and China.

*Remarks* : A favorite sport fish. It is also valued as food fish. It is carnivorous in habit.

*Channa punctatus* (Bloch)

1793. *Ophiocephalus punctatus* Bloch. *Naturges. ausland, Fische*, (7) : 139, pl. 358. (Type-locality: rivers and lakes of Coromandel coast); Day, 1876, *Fishes of India*: 367, pl. 78, fig. 1 : Day, 1889, *Fauna Br. India*, *Fishes*, 2 : 364; Deraniyagala; 1929, *Spolia Zeyl.*, 15 (2) : 90, pl. 26.

*Diagnostic characters* : Body elongate and fairly rounded, eyes moderate, mouth large, lower jaw longer, maxillary reaching to below on behind hind border of eyes. Pectoral fins extend to anal fin, pelvic fin about 75% of pectoral fin length. Caudal fin rounded. Dorsal, anal and caudal fins dark grey, sometimes with a reddish tinge, paired fins pale orange.

*Distribution* : India.

*Elsewhere* : Afghanistan, Pakistan, Sri Lanka, Nepal, Bangladesh, Myanmar and Yunnan (China).

*Remarks* : Prolific breeder.

*Channa striatus* (Bloch)\*

1793. *Ophiocephalus striatus* Bloch. *Naturges. ausland. Fische*, (7) : 141, pl. 359. (Type locality : Malabar); Day, 1876, *Fishes of India*: 366; Day, 1889. *Fauna Br. India*, *Fishes*, 2 : 363; Deraniyagala; 1929, *Spolia Zeyl.*, 15(2) : 86, pl. 25.

*Diagnostic characters* : Body elongate and fairly rounded, eyes moderate, mouth large, pectoral fin about 2 times in head length, no barbels, caudal fin rounded, dark greyish to black above, yellowish white below patchy greyish bands descend from side to abdominal region, fins greyish.

*Distribution* : India.

*Elsewhere* : Pakistan, Sri Lanka, Bangladesh, Nepal, Myanmar, Malaya archipelago, Thailand and south China.

*Remarks* : A popular and highly priced fish especially when freshly caught. The flesh is firm, white, practically boneless and of almost agreeable flavors.

#### Family MASTACEMBELIDAE

#### Genus *Mastacembelus* Scopoli

#### *Mastacembelus armatus* (Lacepede) \*

1800. *Macrogathus armatus* Lacepede, *Hist. Nat. Poiss.*, 2 : 286. (Type-locality : not known).

1921. *Mastacembelus manipurensis* Hora. *Rec. Indian Mus.*, 22; 206, pl. 9, fig. 3. (Type-locality: nr. Thanga Id., Manipur); Sufi, 1956, *Bull. Raffles Mus.*, (27) : 142.

*Diagnostic characters* : Body slender, mouth small, snout tri-lobed with a fleshy prolonged projecting. Spinous dorsal fin inserted above middle or posterior-third of pectoral fin. Dorsal and anal fins broadly joined to caudal fin.

*Distribution* : India.

*Elsewhere* : Pakistan, Sri Lanka, Nepal, Myanmar, Thailand, Malaya and Southern China.

*Remarks* : It is a good food fish.

### SUMMARY

The fishes recorded from Pichhola Lake are a treasured resource both in terms of their utility as food and as material for scientific study. The present record of pisces diversity in Pichhola Lake shows increasing trend of economically important food fishes. Total 26 fishes were recorded out of which three are new records. In all 42 species reported so far from Pichhola Lake are described. Due to the lack of identification confirmation, most of the game and aquarium fishes have not been included though large numbers of such collections were made from different niches of the lake waters.

The lake is being gradually polluted endangering the fish fauna. Fishery is not very lucrative; though it holds a great promise for development of commercial fishery if proper management measures are judiciously adopted. Pichhola Lake is on the International tourist map and it attracts large number of tourists from around the world. Excellent game fishes like *Puntius* and *Tor* abound in this lake and development of game fishery in this lake would greatly boost the prospects of tourism industry in Udaipur city. The lake holds great potential for both food and game fishes to be used for tourism promotion in the region.

### ACKNOWLEDGEMENTS

The authors are thankful to Dr. R.A. Khan, Director and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata and the Officer-in-charge, Desert Regional Station, Z. S. I., Jodhpur for providing all facilities to carry out the work. We are also thankful to Dr. K.P. Sharma, Deputy Director, Fisheries, Udaipur for confirming the fish species identification and various useful suggestions.

### REFERENCES

- Ajithkumar, C.R. 1990. The fish community of Keoladeo National Park, Baratpur, Rajasthan. India. In: *Proc. of the IInd Asian Fisheries Forum*, Tokyo, Japan, April 1989. (eds.) R. Hirana and I. Hanyu. The Asian Fisheries Society, Manila. Philippines : 385-388.
- Ajithkumar, C.R. 1991. Community and habitat segregation of the fish in Keoladeo National Park. Kanpur University, Ph.D. Thesis.
- Ajithkumar, C.R. 1993. *Aplocheilus panchax* (Ham.) - an addition to the fish fauna of Rajasthan. *J. Bombay nat. Hist. Soc.*, **90**(1) : 115.
- Ajithkumar, C.R. and Asthana, A. 1993. The fish fauna of Rajasthan, India. *Rev. Life Sci.*, **13** : 133-148.
- Ajithkumar, C.R. and Mittal, D.D. 1993. Habitat preference of fishes in wetlands in relation to aquatic vegetation and water chemistry. *J. Bombay nat. Hist. Soc.*, **90**(2) : 181-192.
- Ajithkumar, C.R. and Sankar, K. 1993. Ichthyo-fauna of Sariska wild life sanctuary. *J. Bombay nat. Hist. Soc.*, **90**(2): 299-300.
- Ajithkumar, C.R., Ramachandran, N.K. and Asthana, A. 1995. Composition, abundance and distribution of fish in Banganga gambhir river system source of fish to the Keoladeo National Park, Bharatpur. *J. Bombay nat. Hist. Soc.*, **92**(1) : 30-39.

- Anonymous, ?. Birds and Fishes of Lake Palace (Pichhola), Udaipur. Published by Lake Palace Hotels and Motels Pvt., Udaipur-India.
- Chaudhary, R.S. 1978. Fish and fisheries of Rana Pratap Sagar. *J. Inland Fish. Soc. India*, **10** : 76-84.
- Datta Gupta, A.K., Menon, P.K.B., Nair C.K.G and Das, C.R. 1961. An annotated list of fishes of Rajasthan. *Proc. Rajasthan Acad. Sci. Pilani*, **8**(1 & 2) : 120-134.
- Datta, A.K. and Majumdar, N. 1970. Fauna of Rajasthan, India, Part 7 Fishes. *Rec. zool. Surv. India*, **62**(1 & 2) [1964] : 36-100.
- Dhawan, S. 1967. Fish Fauna of Udaipur Lakes. *J. Bom. Nat. Hist. Soc.* **66**(1) : 190-194.
- Dhawan, S. 1967. Fish Fauna of Udaipur lakes. *J. Bombay nat. Hist. Soc.*, **66**(1) : 190-194.
- Dubey, G.P. and Mehra, R.K. 1962. Fish and Fisheries of Chambal River. *Proc. First All India cong. Zool. Jabalpur*, pt. **II** : 647-665.
- Durve, V.S. 1976. The fisheries of the lake Jaisamand, Rajasthan. *J. Inland Fish. Soc. India*, **8** : 19-23.
- Durve, V.S. and Kakkar, V.K. 1977. Fishery of selected impoundment around Udaipur. *Proc. All India Seminar on Ichthyology*, **44** : 23-24.
- Durve, V.S. and Kakkar, V.K. 1979. Fishery of Guda reservoir in Bundi district (Rajasthan). *Seafd. Export J.*, **11**(6) : 9-14.
- Durve, V.S. and Rajbanshi, V.K. 1975. Fish mortality and fishing during an unprecedented drought in lake Pichhola, Udaipur. *Indian J. Fish.* **22**(122) : 297-299.
- Gupta, S.N. and Kulshreshta, S.D. 1985. Fish and fishery of the District Jhalawar, Rajasthan. *Intl. J. Acad. Ichthyol.*, **6** : 91-96.
- Hora, S.L. and Mathur, B.B.L. 1952. On certain palaeographical features of Rajasthan as evidenced by distribution of fishes. *Bull Nat. Inst. Sci. India*, **1** : 32-36.
- Jhingran, A.G. 1989. Limnology and Production Biology of two man made lakes in Rajasthan (India) with Management strategies for their fish yield optimisation" A final report of IDA assisted pilot project on reservoir fisheries management in Rajasthan, submitted to Ministry of Agriculture, Government of India, New Delhi.
- Johal, M.S. 1982. Field key to the fishes of Ganganagar district, Rajasthan. *Res. Bull. Punjab Univ.*, **33** : 43-49.

- Johal, M.S. and Dhillon, K.S. 1981. Ichthyofauna of Ganganagar district (Rajasthan), India. *Res. Bull. Punjab Univ.*, **32** : 105-107.
- Johal, M.S. and Sharma, K.P. 1986. Fish fauna of Swaimadhapur district, Rajasthan State, India. *Vest cs. Spolec. Zool.*, **50** : 112-119.
- Johal, M.S., Chahal, I. S. and Tandon, K.K. 1993. Ichthyofauna of Rajasthan State. *J. Bombay nat. Hist. Soc.*, **90** : 404-411.
- Kohli, Singh, M.P. Prakash, C. and Jadhav, R.J. 1998. Aquatic productivity indices in four tribal districts of Rajasthan with special reference to fisheries development. *Punjab Fish. Bull.*, **XX** (1) : 53-62.
- Krishna, D and Menon, C.B. 1958. A note on the fishes of Jodhpur (Rajasthan) (In Hindi) *Vijnana Parishad Anusandhan Patrika*, **1** (4) : 207-209.
- Kumar, C.R.A. and Asthana, A. 1993. Fish fauna of Rajasthan. *Indian Review of Life Sciences*, **13** : 133-148.
- Kumar, Sanjeev and Rathore, N. S. 1999. Faunal diversity and State of Health of Pichola Lake, Udaipur-A cases study. In: *International Conference on Tropical Aquatic Ecosystems: Health, Management and Conservation*, Nainital, India October, 25-30, 1999. Abstract : 86.
- Mathur, B.B.L. 1952. Notes on fishes from Rajasthan. - India. - *Rec. Indian Mus.*, **50**(1) : 105-110.
- Mathur, D.S. 1977. On a collection of fishes from Jodhpur District (Rajasthan). *Newslett. Zool. Surv. India*, **3**(4) : 158-159.
- Mathur, D.S. and Yazdani, G.M. 1973. Additional record of fish from Jodhpur with a list of species occurring in the district. *Sci and Cult.*, **39**(1) : 87-89.
- Moona, J.C. 1963. Notes on fishes from Bharatpur District Rajasthan. *Rec. Indian Mus.*, **58**(2) : 59-66.
- Nama H.S. 1987. Helminth parasites from freshwater fishes in Rajasthan. *2nd Int. Symp. Ichthyoparasitology*, Sept. 27 Oct. 3, 1987, Tihany. Hungary : 69 Abt.
- Saxena, M.M. 1984. Commercial fishes, their sale and some economic aspects of the trade in the fish market of Jodhpur (Rajasthan, India). *Intr. J. Acad. Ichthyol.*, **5** : 181-182.
- Saxena, M.M. and Rathore, N.S. 1995. Sewage fish culture in desert town Bikaner: A case study. *DECO Mirror*, **2**(4) : 45-48.
- Sharma, Arvind 1991. Toxic effect of zinc and cadmium on embryonic development of selected freshwater Fishes. Ph. D. Thesis. Deptt. Zoology, M.L. Sukhadia University, Udaipur.

- Sharma, K.P. and Johal, M.S. 1982. On the fish and fisheries of Jaisamand Lake, Rajasthan, India. *Vest cs. Spolec. Zool.*, **46** : 56-69.
- Sharma, K.P. and Kulshreshta, S.D. 1991. Fishes and fisheries of Kota district, Rajasthan. *J. Zool. Soc. India*, **33** : 63-70.
- Sharma, K.P., Tyagi, A.P. and Saxena, Ranjana. 1984. Fisheries potential of the Thar Desert, India. *Proc. Sem. Eff. Pest. Aq. Fau.*, : 91-97.
- Sharma, M.S. and Durve, V.S. 1985. Trophic status and fishery potential of Rajasthan waters *Proc. Nat. Sympos. Evalu. Environ. (Spl. Vol. Geobios)* (eds.) S.D. Misra, D.N. Sen and I. Ahmed [1981], pp. 180-186.
- Talwar, P.K. and Jhingran, A.G. 1991. Inland fishes of India and adjacent countries. Vo. I and II, ix-1097. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Tiwari, K.K. 1968. A new fossil period fish from lower tertiary Fuller's Earth Deposits of Kapurdi, Barmer district, Rajasthan. *J. Zool. Soc. India*, **20** : 95-103.
- Vyas, L.N. 1986. Ecology and Conservation of Lakes in and around Udaipur (Rajasthan) Final Project MAB Project No. 20/46/81-MAB/ENV-2. Department of Botany, College of Science, Sukhadia University, Udaipur.
- Yazdani, G.M. 1996. Fish diversity in the Thar Desert. In : *Faunal Diversity in the Thar Desert : Gaps in Research* (eds.) A.K. Ghosh, Q.H. Baqri and I. Prakash), Scientific Publishers, Jodhpur, India, **30** : 285-295.



**Table-1** : List of Fish species recorded from Pichhola Lake.

Name of the species	Local name	Size (cm)	Remarks
<i>Notopterus notopterus</i> (Pallas)*	<i>Chitala</i>	44	Very commonly used for fish soup
<i>Catla catla</i> (Hamilton-Buchanan)**	Catla	97	Food fish
<i>Chagunius chagunia</i> (Hamilton- Buchanan)*	Puthi	07	Aquarium fish
<i>Cirrhinius mrigala</i> (Hamilton-Buchanan)*	Mrigal	88	Fairly valued as food fish
<i>Cirrhinius reba</i> (Hamilton-Buchanan)*	Reba	30	Very rare
<i>Labeo bata</i> (Hamilton-Buchanan)*	Bata	30	Very rare
<i>Labeo boggut</i> (Sykes)	Dudhya	20	Rare, table fish
<i>Labeo calbasu</i> (Hamilton-Buchanan)*	Kalaunt	90	Very common
<i>Labeo fimbriatus</i> (Bloch)**	Belji	21	Common carp
<i>Labeo gonius</i> (Hamilton- Buchanan)*	Sarsi	65	Abundant
<i>Labeo rohita</i> (Hamilton- Buchanan)*	Rohu	90	Very common, table fish
<i>Puntius chola</i> (Hamilton-Buchanan)	Siddhari	10	Rear, rich in oil
<i>Puntius s. sarana</i> (Hamilton-Buchanan)*	Puthi	27	Common, table fish
<i>Puntius sophore</i> (Hamilton-Buchanan)*	Khursa	07	Common, aquarium fish
<i>Puntius ticto</i> (Hamilton-Buchanan)*	Chidhu	07	Common, aquarium fish
<i>Tor khudree</i> (Sykes)*	Mahseer	60	Common food & game fish
<i>Chela cachius</i> (Hamilton-Buchanan)	Silver chela	06	Very common, Table fish
<i>Chela laubuca</i> (Hamilton-Buchanan)*	Chal	17	Common, Larvicidal fish
<i>Securicula</i> sp	Gora chela	19	Very rare
<i>Amblypharyngodon mola</i> (H. -Buchanan)	Melwa	10	Common
<i>Barilius barna</i> (Hamilton-Buchanan)	Gala	07	Very rare
<i>Barilius bendelisis</i> (Hamilton-Buchanan)	Galva	15	Common

Name of the species	Local name	Size (cm)	Remarks
<i>Brachydanio rerio</i> (Hamilton-Buchanan)	Chaudlore	10	Very rare
<i>Rasbora rasbora</i> (Hamilton-Buchanan)*	Zebra	15	Common
<i>Garra gotyla gotyla</i> (Gray)	Pathar chata	15	Very rare, bottom feeder
<i>Nemachelius botia</i> (Hamilton-Buchanan)	Bamna	05	Very rare, Aquarium fish
<i>Lepidocephalus guntea</i> (H. - Buchanan)*	Paharimachi	07	Very rare, Aquarium fish
<i>Botia lohachata</i> Chaudhuri	Bamna	15	Rare Aquarium fish
<i>Aorichthys aor</i> (Hamilton-Buchanan)**	Kataarna	64	Table fish
<i>Aorichthys seenghala</i> (Sykes)*	Singhara	118	V. Common, Predaceous
<i>Mystus bleekeri</i> (Day)*	Katarna	12	Very rare
<i>Mystus cavasius</i> (Hamilton-Buchanan)*	Kataya	22	Common
<i>Ompok bimaculatus</i> (Bloch)*	Palwa	27	Rare, rich in oil
<i>Wallago attu</i> (Schneider)*	Lanchi	245	Very common, predaceous and table fish
<i>Clarias Scolopi</i>	-	-	-
<i>Heteropneustes fossilis</i> (Bloch)	Singhi	30	Common with poisonous spines
<i>Xenentodon cancila</i> (Hamilton-Buchanan)	Suyia	30	Very common
<i>Chanda nama</i> Hamilton-Buchanan	Channa	11	Common, larvicidal fish
<i>Channa marulius</i> (Hamilton-Buchanan)*	Saval	120	Rare, good table fish
<i>Channa punctatus</i> (Bloch)	Kabra	20	Very rare
<i>Chana striatus</i> *	Shawl	40	Common, table fish
<i>Mastacembelus armatus</i> (Lacepede)*	Bam	60	Common, rich in fat

## Chapter 9

# Amphibia



N. S. Rathore and S. Kumar



Indian Bull Frog : *Haplobatrachus tigerinus*

## AMPHIBIA

N.S. RATHORE AND S. KUMAR

Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan

### INTRODUCTION

The group amphibia is poorly represented in Rajasthan. Out of 206 species known in India, ten species viz. *Occidozyga cyanophlyctis*, *Occidozyga hexadactyla*, *Limnonectes limnocharis*, *Tomopterna breviceps*, *Heplobatrachus tigerinus*, *Bufo melanostictus*, *Bufo andersoni*, *Microhyla ornata*, *Uperodon systema* and *Polypedates maculatus* have been recorded so far from this state by Mansukhani and Murthy (1964), Bohra *et al.* (1983) and Sharma (1995). The amphibian species diversity of wetlands of Rajasthan is yet not known and the present attempt is aimed towards recording the same. The study deals with three species of amphibians collected from Pichhola Lake, Udaipur. Standard hand net and direct hand catch or forceps were used to collect the specimens from different niches. Chloroformed specimens were preserved in 5 % formalin and abdominal incision was made to inject 10 % formalin for fixation of viseral organs. Classifications followed are that of Boulenger (1920), Parker (1934) and Daniel (1963).

### SYSTEMATIC ACCOUNT

Class    AMPHIBIA  
Order    ANURA  
Family   MICROHYLIDAE

Genus *Microhyla* Tschudi, 1838

*Mircohyla ornata* (Dumeril and Bibron) 1841

Ornate Microhylid

1841. *Enqystoma ornatum* Dumeril and Bibron, *Erpet. Gen.*, 8 : 745.

1934. *Microhyla ornata* Parker, *Monogr. Microhylidae* : 139-141.

1984. *Microhyla ornata* Sarkar, *Bull. Zool. Surv. India*. 6(1-3) : 92.

*Material examined* : 4 exs., 30.iii.97, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : Head broader than long, snout obtusely pointed, nostrils far from the eyes, near the tip of the snout, tympanum not much distinct. Fingers free with flattened tips. Toes with blunt tip and a rudimentary web. Dorsum smooth, brownish with broad darker markings. Venter smooth, dull whitish, little darker on throat.

*Distribution* : Widely distributed all over the plains of India upto 1524 m. AMSL and in Rajasthan (Ajmer, Pali, Sirohi and Udaipur).

*Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Southeast Asia, South China, Sri Lanka and Taiwan.

*Remarks* : In Pichhola Lake, moist patches and ditches with dry leaves and stony habitats are the hiding places for this species. As soon as the heaps of leaves and stones are turned up, they start jumping and try to quickly hide in safer places.

#### Family RANIDAE

Genus *Heplobatrachus* Linnaeus 1758.

*Heplobatrachus tigerinus* Daudin 1803  
**Indian Bull Frog**

1803. *Rana tigerina* Daudin *Hist. Rain. Gren. crip.*, : 64.

1920. *Rana tigerina* Boulenger, *Rec. Indian Mus.*, 20 : 17-20.

1984. *Rana tigerina* Sarkar, *Bull. Zool. Surv. India*, 6(1-3) : 88-89.

*Material examined* : 1ex., 11.ix.94, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : Head as long as broad, snout round or pointed, projecting beyond the mouth, nostril equidistant both from the tip of snout and the eye, fingers free, tips not sharply pointed, toes entirely webbed, tips not pointed. Dorsum olive green with darker spots, distinct warts and long glandular folds. Venter whitish and smooth.

*Distribution* : The species is common throughout India from the base of the Himalayas to southern part of the country including Andamans. In Rajasthan most parts except extreme desert districts.

*Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka, South China, Thailand and Taiwan.

*Remarks* : Very large size frog and hide under the cover of thick aquatic vegetation and water holes.

***Limnonectus limnocharis* Weigmann 1835  
Cricket Frog**

1835. *Rana limnocharis* Weigmann, *N. Acta Ac. Leop. Carol.*, : 17.

1920. *Rana limnocharis* Boulenger, *Rec. Indian Mus.*, 20 : 28.

1984. *Rana limnocharis* Sarkar, *Bull. Zool. India*, 6(1-3) : 89.

*Material examined* : 1ex., 24.viii.95, 3 exs, 30.iii.97, coll. N. S. Rathore and S. Kumar.

*Diagnosis* : Head as long as broad, snout pointed projecting beyond mouth, nostril nearer to the tip of snout than to eye, tympanum distinct, fingers free, first longer, second smaller than first, tips swollen. Toes distinct, half webbed. Dorsum greyish and with warts. Venter whitish and smooth.

*Distribution* : India : Rajasthan : Jaipur, Nagaur, Pali, Sirohi, Udaipur.

*Elsewhere* : Eastern Asia from Japan and China to India, Sri Lanka, Malaya Peninsula and Archipelago, Eastward to the Philippines, Borneo and Lambok.

*Remark* : Abundantly found in Pichhola Lake and a good food for many water birds.

### SUMMARY

The paper records three species belonging to three genera under two families. The population of *Limnonectus limnocharis* Weigmann was abundantly found in the lake vicinity whereas other two species were rarely observed. Further studies may reveal many more species from the region.

### ACKNOWLEDGEMENTS

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, ZSI, Kolkata and the Officer-in-charge, DRS., ZSI, Jodhpur for providing facilities to carry out the studies on wetland. Thanks are also due to Dr. S.K. Chanda, Scientist-D and O/C Protochordata and Amphibia Section ZSI, Kolkata for confirming the species identification.

### REFERENCES

Bohra, P., Tak, N., Bhargava, R.N. and Rathore, N.S. 1983. Frogs of the Indian Desert with illustrated key to their field identification. *Trans. Isdt. and Ucds.*, 8(2) : 113-118

- Boulenger, G.A. 1920. A monograph of the South Asian, Papuan, Malanesian and Australian Frogs of the Genus *Rana*. *Rec. Indian Mus.*, **20** : 1-226.
- Daniel, J.C. 1963. Field guide to the Amphibians of Western India; part I. *J. Bombay nat. Hist. Soc.*, **60**(2) : 415-438.
- Mansukhani, M.R. and Murthy, T.S.N. 1964. Fauna of Rajasthan, India Part 6, Amphibia. *Rec. zool. Surv. India*, **62**(1-4) : 51- 60 a + 1 Pl.
- Parker, H.W. 1934. A monograph of the frogs of the family Microhylidae, London (Trustees of British Museum) : viii + 208, 67 figs.
- Sharma, S.K. 1995. Amphibians of Rajasthan *Vigyan Parishad Anusandhan Patrika*, **38**(3) : 185-193.

## Chapter 10

# Reptilia



S. Kumar and N.S. Rathore

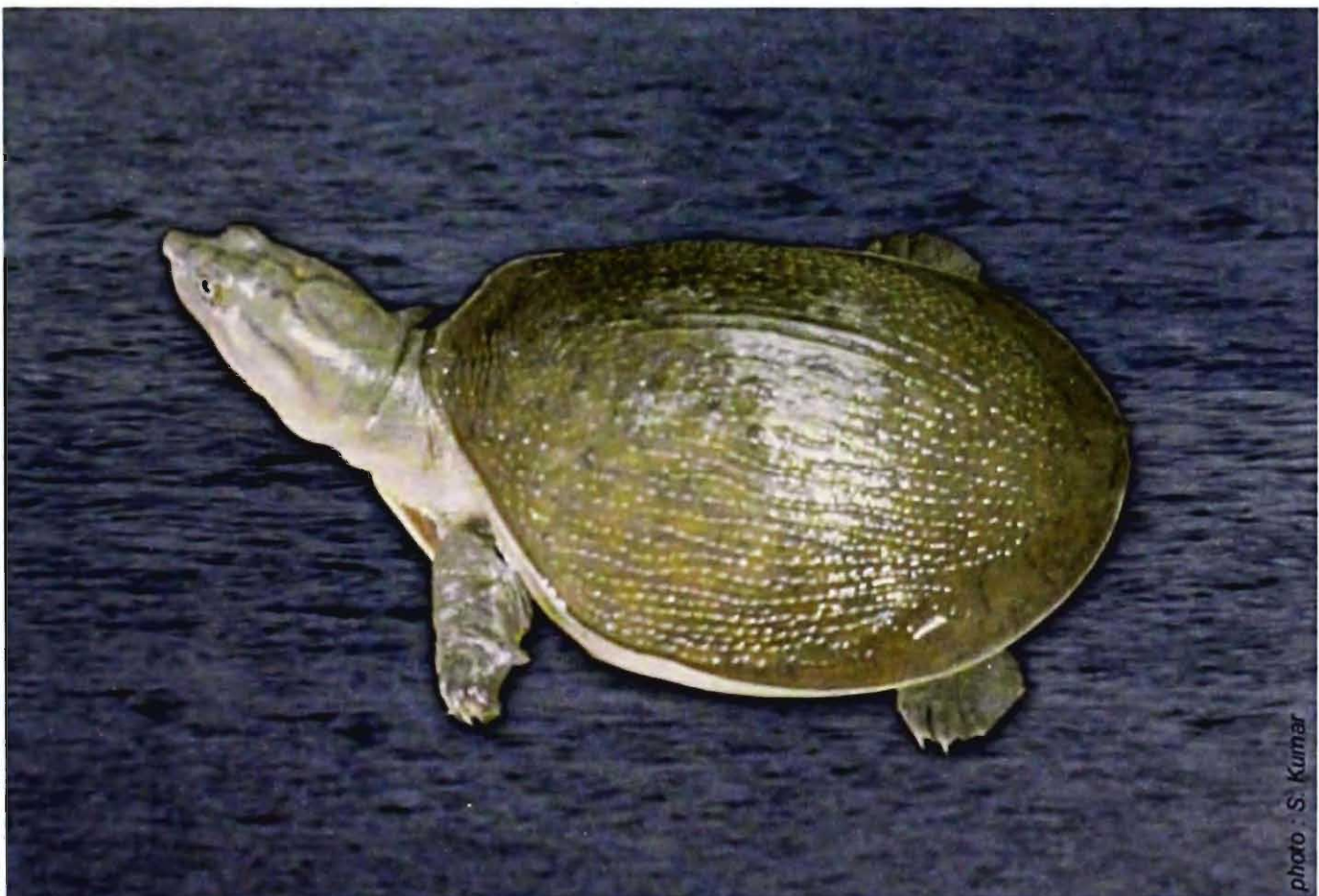


photo : S. Kumar

North Indian Flap- Shelled Turtle

## REPTILIA

S. KUMAR AND N.S. RATHORE

Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan

### INTRODUCTION

Rajasthan is rich in species of colourful and fascinating reptiles and considered as land of reptiles largely due to its vast arid lands. Although they thrive well in other ecological niches as well. Various workers like Prakash (1972), Sharma (1974) and Biswas and Sanyal (1977) have carried out a great deal of work on reptiles of Rajasthan. Tikader and Sharma (1985 and 1992) and Sharma (1998) have also dealt the same. Out of 434 species known from India, 72 species are known from Rajasthan. But so far no special attention has been made to identify reptiles associated with wetlands. Some works are by Bhupathy and Vijayan (1991), Tikader and Sharma (1985) and Sharma (1998) who have reported 14 species of reptiles associated with wetlands of Rajasthan viz. *Crocodylus palustris*, *Gavialis gangeticus*, *Kachuga tecta*, *Kachuga circumdata*, *Kachuga dhongoka*, *Kachuga kachuga*, *Kachuga smithi*, *Hardella thrugii*, *Geoclemys hamiltoni*, *Lissemys punctata punctata*, *Chitra indica*, *Trionyx gangeticus*, *Trionyx hurum* and *Xenochrophis piscator*. The present study is based on a small collection of reptiles made from Pichhola Lake and its surroundings from 1994 - 1997. The collection comprises seven species of reptiles, which includes turtles, lizards and snakes. One species of crocodile and one species of snake were also observed and identified from the wetland. The classification followed is that of Sharma (1998) for testudines and crocodilia, Tikader and Sharma (1992) for lizards and Minton (1966) for serpents.

### SYSTEMATIC ACCOUNT

Order TESTUDINES

Family TRIONYCHIDAE

Genus *Lissemys* Smith 1931

1931. *Lissemys* Smith, *Fauna British India*. 1 : 147-149.

1985. Tikader and Sharma, *HandBook Indian Testudines* : 118-120, pl. 31, figs. 72, 73.

***Lissemys punctata punctata* (Lacepede) 1788****North Indian Flap-Shelled Turtle**

1788. La Tortue chagrinee, *Hist. Quad. Ovip.*, 1 : 171, pl. 11.

1985. Tikader and Sharma, *HandBook Indian Testudines* : 118-120, pl. 31, fig. 72, 73.

1998. Sharma, *Fauna of India Reptilia (Testudines and Crocodilia)*, 1 : 125, 126, fig. 145, 146.

*Material examined* : 1 ex., 11.ix.94, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : A small turtle with moderately large head, short and broad snout. The carapace and plastron covered by a continuous sheet of soft skin. Plastron is with soft, semicircular flaps. Limbs are fully webbed with only three claws on each foot. Tail short, olive brown above. Carapace grey-green with numerous black bordered yellow spots.

*Distribution* : India : Andaman Islands, Ganga river system, Gujarat (Kutch) and Sikkim.

*Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan (Sind river system) and Sri Lanka.

*Habit and Habitat* : Inhabits ponds, tanks and lakes with shallow muddy bottom. Carnivorous; feeds on frogs, fishes, shrimps and snails.

*Remarks* : A group of 6-8 turtles were often seen basking in the Sun resting on a exposed tree trunk bending towards the lake waters in the extreme south-eastern shallow water zone having congregation of drifted *Eichhornia*. Although they are not so commonly found in other parts of the lake but wetland supports good population.

**Genus *Trionyx* Geoffery 1809**

1809. *Trionyx* (in part) Geoffery. *Ann. Mus. Hist. nat. Paris.* 14 : 4 & 20 (Type *Trionyx aegyptiacus*).

1985. Tikader and Sharma, *Hand Book Indian Testudines* : 127-129, pl. 35, 38 & 47, fig. 78, 79.

1998. Sharma, *Fauna of India – Reptilia (Testudines and Crocodilia)*, 1 : 135-137, fig. 159-162.

***Triònyx gangeticus* Cuvier 1825****Indian soft-shelled Turtle or Ganga soft-shelled Turtle**

1825. *Trionyx gangeticus* Cuvier, *Oss. Foss.*, 5 : 186, 203, 206. pls. 11 & 12 (Type loc. Ganges : Paris *Mus. Nat. Hist.*)

1985. Tikader and Sharma, *Hand Book Indian Testudines*, : 127-129, pls. 35, 38 & 47, fig. 78, 79.

1998. Sharma, *Fauna of India – Reptilia (Testudines and Crocodilia)*, 1 : 135-137, fig. 159-162.

*Material examined* : Carapace of a dead specimen, 13.ix.94, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : A large turtle with soft oval shell. Head large and broad with dorso-lateral eyes, proboscis elongated. Carapace coarsely pitted and vermiculated. Limbs with three claws. Tail short. Dorsally olive green in colour, plastron ivory white, head greenish.

*Distribution* : India : Ganga, and Mahanadi river system.

*Elsewhere* : NW Pakistan (Sind river system), Bangladesh and Nepal foothills.

*Habit and Habitat* : Natural habitat is deep turbid waters of the rivers but comes to the lake habitat along with flowing water in rainy season. Carnivorous species and main food includes aquatic vegetation, fishes, molluscs, frogs and crustaceans. Breeding period is from September-October.

*Remarks* : Not so common. Rarely sighted by local fishermen's. One carapace of a dead animal was collected from a shallow water margin on the southern side near Shrike's thicket area of the lake.

Order CROCODYLIA

Family CROCODYLIDAE

Genus *Crocodylus* Gronovius 1763

1763. *Crocodylus* Gronovius *Zoophyl. fasc. i* : 10.

*Crocodylus palustris* Lesson 1834

**Marsh crocodile or Mugger**

1834. *Crocodylus palustris* Lesson, in *Belang. Vov. Ind. or, Zool.*, : 305 (Type loc. Ganges).

1977. *Testudines, Crocodylia, Rhynchocephalia*. Wermuth and Mertens, *Das Tierreich*, 100 : 1-174.

1998. Sharma, *Fauna of India – Reptilia (Testudines and Crocodylia)*, 1 : 150-152, fig. 176-179.

*Material examined* : One crocodile was observed on a small island near crocodile channel in the lake.

*Diagnosis* : Moderately large 3 to 5 metres in length, snout short and broad devoid of ridges in front of the eyes. Body strongly armoured. Fingers webbed at the base, outer limbs bear serrated fringes. Colour dark olive green.

*Distribution* : The mugger occurs in scattered and isolated population over most of India: Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and beyond

Darrang district in to Arunachal Pradesh except the states of Jammu and Kashmir, Himachal Pradesh, and Punjab in the extreme northwest and the northwest desert region.

*Elsewhere* : The range also includes parts of Bangladesh, Iran, Nepal, Pakistan and Sri Lanka.

*Habit and habitat* : Occurs in any kind of freshwater habitat but prefers water with 3-5 m. depth. May be present in rivers streams, jungle, pools and frequently found in man-made lakes (tanks).

*Remarks* : Endangered species. The Lake Palace authorities reported two crocodiles however only one animal was seen basking in the sun on a small Island near crocodile channel.

Order SQUAMATA  
Suborder SAURIA  
Family GEKKONIDAE

Genus *Hemidactylus* Oken 1817

1817. *Hemidactylus* Oken. *Isis*, : 1183.

1935. Smith, *Fauna of British India* II Sauria, : 1-440.

***Hemidactylus leschenaulti* Dumeril and Bibron, 1836**  
**Common Bark Gecko**

1836. *Hemidactylus leschenaulti* Dumeril and Bibron, *Erp. Gen.* 3 : 364 (Type loc. Sri Lanka).

1985. Smith. *Fauna of British India*, 2 : 97.

1992. Tikader and Sharma, *Handbook Indian Lizards*, : 59, 60, pl. 8-A, fig.10.

*Material examined* : 1 ex., 11.ix.94, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : Large ashy grey gecko, a black stripe emerges from behind the eye and extends upto flanks, belly whitish, head large with a broad snout, head covered with small granular scales, larger near the snout. Dorsum with small granular scales, digits free, moderately dilated, with slightly oblique lamellae. Tail is almost equal to head and body, strongly depressed.

*Distribution* : India : Peninsular region, Gujarat, Rajasthan and West Bengal.

*Elsewhere* : Pakistan and Sri Lanka.

*Habit and Habitat* : This species is arboreal and its most favorable abodes are large trees of banyan, tamarind and mango. Breeding period is from March-May.

**Remarks** : Available in abundance. Collected from under the bark of *Eucalyptus* tree in the shoreline-forested land. It is reported for the first time from Pichhola Lake, Rajasthan. It is new record from Pichhola Lake, Udaipur, Rajasthan.

Family SCINCIDAE

Genus *Riopa* Gray 1839

1839. *Riopa* Gray, *Ann. Mag. Nat. Hist.* 2 : 332 (Type *Lygosoma punctata*).

1935. Smith. *Fauna British India*, 2 : 312

***Riopa punctata* (Linnaeus 1766)**  
**Dotted Garden Skink**

1766. *Lacerta punctata* Linnaeus, *Sys. Nat.* : 369 (Type loc. Asia)

1966. Minton, *Bull Amer. Mus. nat. Hist.*, 134 : 104.

1992. Tikader and Sharma, *Handbook Indian Lizards*, : 147, pl. 39B

**Material examined** : 1 ex., 9.iii.1995, coll. N. S. Rathore and S. Kumar.

**Diagnosis** : Dorsum brown, scale with a dark basal spot, a yellow dorso-lateral stripe start from the snout, belly is yellowish white, each scale dotted with black, tail red in young lizards. Snout pointed, body scales smooth and equal. Digits long, fourth toe is longer than the third. Tail swollen at the base, slightly longer than the head and body.

**Distribution** : India : Almost whole of India.

**Elsewhere** : Sri Lanka, Man-son mountains and Tonking.

**Habit and Habitat** : Generally ground dwelling, insectivorous and oviparous.

**Remarks** : Commonly found around Pichhola Lake. Collected from partially grooved tamarind tree trunk filled with soil in the shoreline-forested land. It is reported for the first time from Pichhola Lake, Udaipur, Rajasthan.

Family LACERTIDAE

Genus *Cabrita* Gray 1838

1838. *Cabrita* Gray, *Ann. Mag. Nat. Hist.* i, : 282.

***Cabrita jerdoni* Beddome 1870**  
**Indian Golden Cabrita**

1870. *Cabrita jerdoni* Beddome, *J. Med. Sci.*, : 34.

1935. Smith, *Fauna British India*, 2 : 375.

1992. Tikader and Sharma, *Handbook Indian Lizards*, : 173, pl. 25-A.

*Material examined* : 1 ex., 9.iii.1995, coll. N. S. Rathore and S. Kumar.

*Diagnosis* : Almost six inches in length, Dorsum brownish with two yellowish lateral stripes extending upto the tail on each side. Dorsum and space between the two stripes is filled with black circular spots. It differs from the snake-eyed lacertids in having large transparent disks in the centre of the lower eyelids, which remain movable.

*Distribution* : India: Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra and Uttar Pradesh.

*Habit and Habitat* : Swift moving lizards and found mostly in the dry forested grasslands. Lay about six eggs. It is reported for the first time from Pichhola Lake, Udaipur, Rajasthan.

*Remarks* : It is not so commonly found but collected from dry margins of the forested land around Pichhola Lake.

#### Genus *Ophisops* Menetries 1832

1832. *Ophisops* Menetris, *Cat. Rais.*, : 63 (Type *elegans*).

1935. Smith, *Fauna British India*, 2 : 376.

#### *Ophisops jerdoni* Blyth 1853 Punjab Snake-eyed Lacerta

1853. *Ophisops jerdoni* Blyth. *J. Asiat. Soc. Beng.*, 22 : 653 (Type loc. Mhow, Indore, Madhya Pradesh).

1935. Smith, *Fauna British India*, 2 : 377.

1992. Tikader and Sharma, *Handbook Indian Lizards*, : 174, pl. 25-A.

*Material examined* : 1 ex., 13.ix.1994, coll. N.S. Rathore and S. Kumar.

*Diagnosis* : 4-8 inch long. Dorsum golden or greyish with two golden lateral stripes, the upper extending from the supra ciliary margin to the tail, the space between the two stripes and the upper margin of the upper stripe is densely spotted with black, belly is yellowish white. Upper head shield strongly keeled and striated, dorsal scales almost equal, as large as the caudal. Lower eyelids transparent.

*Distribution* : India : Andhra Pradesh, Maharashtra and Tamil Nadu.

*Elsewhere* : Pakistan.

**Habit and Habitat** : In western Rajasthan it is commonly seen during daytime on loose sandy soil. Feeds on termites, spiders and small insects.

**Remarks** : A common species. In Pichhola Lake, found on rocks with vegetation. It is reported for the first time from Pichhola Lake, Udaipur, Rajasthan.

Suborder SERPENTES

Family TYPHLOPIDAE

Genus *Typhlops* Opperl 1811

1811. *Typhlops* Opperl, *Ordn. Rept.* 54 (Type *lumbricalis*)

1977. *Ramphotyphlops* Stimson, *Bull Zool. Nomecl.* 33 : 204

***Typhlops braminus* (Daudin) 1803**

**Common or Brahminy Blind Snake**

1803. *Eryx braminus*, Daudin *Hist. Nat. Rept.*, 7 : 279 (Based on Russell, 1796 *Ind. Serp.* i: 48, pl. 43, Vizagapatam).

1985. *Ramphotyphlops braminus*: Murthy, *The Snakes*, 17 : 58.

**Material examined** : 5 exs., 9.iii.1995, coll. N.S. Rathore and S. Kumar.

**Diagnosis** : Worm like burrowing snake, head not distinct from the body, mouth small and inferior, tail is quite small and bears a terminal spinous hook which help the snake in locomotion.

**Distribution** : Widespread throughout India including Andaman and Nicobar Is. In Rajasthan : Bhilwara, Jodhpur, Pilani and Udaipur Districts.

**Elsewhere** : Arabia, Bangladesh, East Indies, Iran, Islands of Indian and Pacific Oceans, Malaysia, Mexico, Myanmar, North and South Vietnam, Pakistan, South China, South Africa and Sri Lanka.

**Habit and Habitat** : Soil dwelling snake found to feed on minute insect larvae living in the roots of the plants; lay eggs.

**Remarks** : Quite common. Collected 5 specimens from roots of grass in which at least 12 to 15 individuals were entangled. As soon as disturbed many of them quickly disappeared in soil. It is reported for the first time from Pichhola Lake, Udaipur, Rajasthan.

Family COLUBRIDAE

Genus *Xenochrophis* Gunther 1864

1864. *Xenochrophis* Gunther, *Rept. Brit. Ind.*, 273 (Type-*cerasogaser*).

1943. Smith, *Fauna British India*, 3 : 317.

1966. Minton, *Bull. Am. Mus. nat. Hist.*, New York, 134(2) : 184.

***Xenochrophis piscator* Schneider 1799**  
**Checkered Keel-back Water Snake**

1799. *Hydrus piscator* Schneider, *Hist. Amph.* 1 : 247.

1943. *Natrix piscator*: Smith, *Fauna British India*, 3 : 293.

1966. Minton. *Bull. Am. Mus. Nat. Hist.*, New York, 134(2) : 184.

*Material examined* : Observed in crevices of stonewalls as well as platform and also stony structures of footsteps of abandoned bathing ghats.

*Diagnosis* : Head oval, distinct from neck, slightly flattened with a blunt pointed snout, eyes large with round pupil. Colour varies from yellowish, olive, light green, grey-brown with a reddish tinge, with five rows of small light black spots, head olive brown with two oblique black streaks one below the other behind the eye.

*Distribution* : India : Widely distributed in whole of India including the Himalayas and the Andamans.

*Elsewhere* : Bangladesh, Borneo, Malayan region, Myanmar, Pakistan, South China, Sri Lanka and Taiwan.

*Habit and Habitat* : A water snake found in all types of aquatic habitat and a fast swimmer. They defend themselves by diving or swimming away from the enemies or by means of emitting foul smelling anal secretion. These snakes mainly feed on amphibians, fishes, small crustaceans and aquatic insects.

*Remarks* : A common species in the locality and found in good number especially on the southwestern side of lake, which is less disturbed.

### SUMMARY

The present paper deals with nine species belonging to nine genera under seven families. Five species viz. *Hemidactylus leschenaulti*, *Riopa punctata*, *Cabrita jerdoni*, *Ophisops jerdoni*, and *Typhlops braminus* are reported for the first time from Pichhola Lake, Rajasthan. The population of *Xenochrophis piscator* was found to be very high in the Pichhola Lake mostly inhabiting the abandoned stony structures all around the shores of the lake. The crocodile was also seen very rarely near small islands and emerging out of water during winter when water level recedes. All other species inhabit surrounding wet area of the lake.

### ACKNOWLEDGEMENTS

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, ZSI, Kolkata, Officer-in-charge, Desert Regional Station for providing facilities to carry out the studies on wetland. Thanks are also due to Dr. S. Sur, Scientist-D, O/C Reptilia Section, ZSI, Kolkata and to Dr. R.C. Sharma, Redt. Scientist ZSI, for confirming the species identification and lucid suggestions.

### REFERENCES

- Biswas, S. and Sanyal, D.P. 1977. Fauna of Rajasthan Reptilia. *Rec. zool. Surv. India*, 73(1-4) : 247-269.
- Bhupathy, S. and Vijayan, V.S. 1991. The fresh water turtle fauna of eastern Rajasthan, *J. Bombay nat. Hist. Soc.*, 88(1) : 118-122.
- Minton, S. 1966. A contribution to the herpetology of West Pakistan. *Bull. Amer. Mus. nat. Hist.*, 134(2) : 27-184.
- Prakash, I. 1972. Notes on little known lizards from Rajasthan Desert. *J. Bombay nat. Hist. Soc.*, 69(2) : 424-428.
- Sharma, S.K. 1998. Aquatic Biota of Rajasthan. In : *Reviving Wetlands : Issues and Challenges. Part-II (7) : 75-94.* Green Arc Society, Himanshu Publications.
- Sharma, R.C. 1974. A report on snakes of Rajasthan. *Indian J. Zool.*, 2(2) : 19-27.
- Sharma, R.C. 1998. Fauna of India and the adjacent countries. Reptilia. (Testudines and Crocodylia) Vol. I. xvi + 1-196. (Ed. & Publ. by the Director, ZSI, Kolkata).
- Tikader, B.K. and Sharma, R.C. 1985. *Handbook Indian Testudines*. 2<sup>nd</sup> Eds. : xii + 1-152 and 47 plates. (Ed. & Publ. by the Director ZSI, Kolkata).
- Tikader, B.K. and Sharma, R.C. 1992. *Handbook Indian Lizards* : xv + 1-250. and 42 plates. (Ed. & Publ. by the Director ZSI, Kolkata).

# Chapter 11

## Aves



S. Kumar and N.S. Rathore



Greater Flamingos - New records from Pichhola Lake

## AVES

**S. KUMAR AND N.S. RATHORE**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### INTRODUCTION

Pichhola Lake harbours rich avian diversity. It has a vast expanse of water with variety of habitats inviting all kinds of birds to take shelter here in its tranquil environment. The tall green trees at Jag Mandir Palace provide an ideal heronry site for various birds like heron, storks and spoonbills to breed and roost in the vicinity of the lake. The building of the helipad inside the lake provides safe place for Cormorants, Indian Sag, Darters and Herons etc. to rest and dive in the waters of Pichhola Lake. Earlier some 240 species of passerine and non-passerine birds were recorded from Pichhola lake waters and evergreen-forested land surrounding the Lake (Anonymous). This is the first major scientific attempt to study the aquatic birds of Pichhola Lake.

In our present attempt to study the avian fauna of Pichhola Lake, the observations were mainly concentrated on aquatic birds visiting open waters, submerged vegetation and shoreline habitat. Only direct sightings in the field were recorded and birds identified with the help of Ali and Riplay (1983) and Woodcock (1983). Specific details of birds were observed with the help of 10 x 50 binocular and wherever possible photographs were taken with the help of 70-210 mm zoom lens with 35mm format SLR camera. The classification followed as Roberts (1991). All the data was recorded during the brief survey visits made in the years 1994-1997. Among 71 species of wetland birds recorded, anatids are largest in number and thirteen species have been sighted for the first time.

Systematic account of waterfowls, shore and upland birds recorded from Pichhola Lake during 1994-1997 is given.

**SYSTEMATIC ACCOUNT****GREBES**

Order PODICIPEDIFORMES

Family PODICIPEDIDAE

Genus : 2, Species : 3

Grebes are specialized fish eating birds having streamlined appearance with legs placed at the rear of the body. They have thickly feathered plumage.

*Tachybaptus ruficollis* (Pallas)**Little Grebe**

This is a smallest of swimming birds found feeding under water. Observed in small groups of 14-20 during winter in the western shore areas and sometimes drafting in open waters near helipad building.

*Podiceps cristatus* (Linnaeus)**Great Crested Grebe**

This is a winter visitor to this lake and found feeding on fishes in open waters. Only 6-8 were spotted in 1995 and 1996.

*Podiceps nigricollis* C.L. Brehm**Black-necked Grebe**

It is a winter migrant to this lake and found to forage individually. Only 4 were seen during 1996.

**CORMORANTS**

Order PELECANIFORMES

Family PHALACROCORACIDAE

Genus : 1, Species : 3

The family is represented by cormorants, the scraggy looking, gregarious, fish eating birds characterized by black plumage and mainly found in inland waters. Three species of cormorants were observed at Pichhola Lake spending their time in feeding and resting on Jag-Mandir, helipad and a small temple like building within Pichhola Lake. Their large quantity of excreta deposited on these buildings are frequently removed and poured into Pichhola lake waters. It is known that their excreta is one of the richest natural fertilizer with high nitrogen and phosphate content. It is also commercially extracted in South America by the name 'guano'

*Phalacrocorax carbo* (Linnaeus)**Great Cormorant**

Seen in large numbers especially during winter accompanying Darters.

*Phalacrocorax fuscicollis* Stephens**Indian Shag**

Commonly seen fishing in flocks in association with little cormorants. Their sun-drying of wings is frequently noticed in the isolated area of south-eastern shores of the lake having stony habitat.

*Phalacrocorax niger* (Vieillot)**Little Cormorant**

Small size and slender body distinguish them from other cormorants. They demonstrate unique prey feeding behaviour on the surface of the water. Abundantly seen resting on helipad and Jag Mandir buildings.

**DARTER**

Order PELECANIFORMES

Family ANHINGIDAE

Genus : 1, Species : 1

Anhinga's or darters resemble extremely slender cormorants with dagger like bills commonly known as snake birds due to their snake like appearance while swimming with just the head and neck shown above the water surface. They share with cormorants the habit of silting for long periods and drying their open wings.

*Anhinga rufa* (Daudin)**Darter**

Darters were not so commonly seen at lake Pichhola. But whenever spotted they were found to catch a fish displaying their fish tossing into the air so as to swallow fish with head first. It is remarkable to see them diving into the water with little disturbance leaving behind the water ripples.

**PELICANS**

Order PELECANIFORMES

Family PELECANIDAE

Genus : 1, Species : 1

Pelicans are social birds that feed in groups and nest in large colonies on the ground. They require a reliable and regular supply of fish. A group herding a shoal of fish into shallower water and than using their huge bills to catch them which they swallows raising the bill upwards.

***Pelecanus onocrotalus* Linnaeus****White or Rosy Pelican**

It is large size bird with robust body and long bill. When soaring in flight its expanse is huge with a marked elegance. It was observed cruising alone in the lake in year 1995, but it use to fly to the near by wetland: Fatehsagar Lake where good flocks of pelicans were found staying. They were exclusively found feeding on fishes.

**HERONS**

Order CICONIIFORMES

Family ARDEIDAE

Genus: 7, Species: 10

Family Ardeidae comprises herons of all shape and size. It's being a patient angler, quietly stands at the water's edge for a fish or frog to show its presence. Herons can be divided into four groups within the family: the true herons are the most widespread and conspicuous members; Night herons are a group of mainly nocturnal species; Bitterns are a group of secretive marsh birds, while tiger herons are less secretive bittern like herons. Some species like Purple heron is even migratory. The true herons include the typical herons, several smaller species and the elegant egrets. Herons are often found breeding in colonies, hence called "heronries" either with their own species or with other species of herons and egrets.

***Botaurus stellaris* (Linnaeus)****Great Bittern**

These secretive birds were observed near shallow region of lake in western part where large *Eichhornia* drifted to the shores and also seen near Fishermen's choice. They were rarely seen 2-4 in number at Pichola Lake.

***Ixobrychus sinensis* (Gmelin)****Yellow Bittern**

Very secretive birds. In 1996, two birds were observed motionless on patches of open water without moving for a long duration to catch a prey. While hunting, they repeatedly wag its stubby tail from side to side.

***Nycticorax nycticorax* (Linnaeus)****Night Heron**

Commonly seen sparsely distributed along shore areas which were less disturbed. Being nocturnal, they are active in dusk and found hunting in solitary. They were even found hunting in day in more forested dark and dense areas along the shore.

*Ardeola grayii* (Sykes)**Indian Pond Heron**

Abundantly seen at the lake and frequently locally migrating to near by smaller wetlands thereby fluctuates their population to a large extent. They were also found roosting on *Acacia* trees.

*Bubulcus ibis* (Linnaeus)**Cattle Egret**

Commonly seen in the shallow or dry margins of the lake especially in region where mud pools are created soon after the monsoon is over and water recedes faster from these elevated margins. They are also frequently seen grazing with buffaloes on the lake margins.

*Egretta garzetta* (Linnaeus)**Little Egret**

They were seen in large number feeding around margins of the lake in the area. Being gregarious in nature, they were observed roosting on trees inside Jag mandir palace.

*Egretta intermedia* (Wagler)**Intermediate Egret**

Maximum of 12 was seen at a time scattered on the southwestern margin of the lake hunting in solitary, otherwise rarely seen.

*Egretta alba* (Linnaeus)**Large Egret**

Always seen to build up its population gradually as day advances. Probably flying daily to near by areas for roosting and coming to lake Pichhola for feeding in the daytime. Their numbers often seem to increase in the midday and once found feeding on water snake.

*Ardea cinerea* Linnaeus**Grey Heron**

They were observed very few in numbers. Rarely seen and on human approach immediately take off with a alarming croak. Mostly seen in heron embakement area.

*Ardea purpurea* Linnaeus**Purple Heron**

They were rarely seen one or two near shrike thicket area and once with grey heron standing secretively motionless to feed on fish or amphibians.

**STORKS**

Order CICONIIFORMES  
 Family CICONIIDAE  
 Genus : 2, Species : 2

They are tall wading birds lacking the elegance of herons. With their long wings they can fly high as well.

*Anastomus oscitans* (Boddaert)  
**Openbill Stork**

They were often observed roosting on trees at Jag Mandir Palace or commonly feeding in shallow margins of the southern side of the lake.

*Ciconia episcopus* (Boddaert)  
**White-necked Stork**

Three were spotted only once in 1995 near stork island on the western side of the lake.

**IBIS and SPOONBILLS**

Order CICONIIFORMES  
 Family THRESKIORNITHIDAE  
 Genus : 3, Species : 3

The family is represented by Ibis and spoonbills. Ibises have strongly decurved bills, whilst spoonbills have long, flat bills, with a broader and rounded tip, therefore the name "spoonbill" They are ground feeding birds, feeding along the margins of the lakes. Ibis while feeding prod here and there with their long bills, feeling for the prey that consists of crustaceans, fish, frogs, insects and molluscs. Whereas spoonbills feel for food, by swinging their bills from side to side as they wade throughout the water. Mostly nest in colonies sometimes with other wading birds.

*Plegadis falcinellus* (Linnaeus)  
**Glossy Ibis**

Commonly seen during winter and feeding on the grassy margins of the lake near wildlife reserve area and along the southern shores. Often seen with black ibis in flocks of 3-5. It allows close approach specially when feeding.

*Pseudibis papillosa* (Temminck)  
**Black Ibis**

They appear much before the glossy ibis on the dry lake margins feeding on insects, crustaceans, reptiles, amphibians and small fishes left in muddle pools. They were seen feeding even in night.

***Platalea leucorodia* Linnaeus**  
**Spoonbill**

Large numbers of birds are seen during winter. Found feeding on shallow water areas of the lake especially in the southeastern shallow margins and frequently changes place. Their flocks of 10-15 were also observed in a near by water body around Pichhola lake.

**FLAMINGOS**

Order PHOENICOPTERIFORMES

Family PHOENICOPTERIDAE

Genus : 1, Species : 1

Flamingos are the most beautiful birds, with their long legs and neck. Soon after the monsoon, flamingos in-groups are frequently seen on even smaller wetlands throughout the northern India, specially in saline wetlands. But they also prefer freshwater bodies with high pH.

***Phoenicopterus ruber* Linnaeus**  
**Greater Flamingo**

Six adults of this spectacular tall bird were seen during winter of 1995 and they stayed at the lake for three days. They were seen flying all over the lake frequently change their place in near margins of lake water. Reported for the first time from Pichhola Lake.

**GEESE and DUCKS**

Order ANSERIFORMES

Family ANATIDAE

Genus : 5, Species : 11

Anatids is a group of swan, geese and ducks. The most evocative sight and sound is that of migrating geese. They are an extremely varied assortment of water birds seen on suitable wetlands habitat throughout the world. Ducks feeding in water and diving are quite fascinating to a bird watcher. Heavy bodied birds frequently needs runway of clear water for take off. They feed on variety of food available in the wetlands.

***Dendrocygna javanica* (Horsfield)**  
**Lesser Whistling Teal**

Commonly seen during summer at Pichhola Lake feeding in shallow areas with water locked in pockets. Their flocks were seen in open waters ahead of helipad

building right in the centre of Pichhola Lake. Fairly good numbers (17-25) arrives here at this wetland.

*Nettapus coromandelianus* (Gmelin)  
**Indian Cotton Teal**

It is a small perching duck but always found in the weed-infested areas feeding mainly on them. A flock of 12 was seen at Pichhola Lake in the year 1995.

*Tadorna ferruginea* (Pallas)  
**Ruddy Shelduck**

This beautiful duck marks its presence due to its distinct colours and always-sighted in pairs. 3-4 pairs were seen in 1994 and 1996 resting/sleeping on a small island near Jag-Mandir Palace or feeding near submerged vegetation zone around Pelican corner southwest of the lake.

*Anas penelope* Linnaeus  
**Wigeon**

It is a winter visitor to the lake and found feeding during night in the shallow regions with submerged vegetation or sometimes seen drifting in open waters. Their numbers were quite variable from 3-5 at Pichhola Lake during the period from 1994-1996.

*Anas strepera* Linnaeus  
**Gadwall**

Often confused with Mallard, the Gadwalls are also winter visitors to this lake. They were commonly seen at Pichhola Lake numbering 14-20 widespread throughout the lake along with coots in open waters.

*Anas crecca* Linnaeus  
**Common Teal**

They were seen in flocks near the shallow water confinements along the western end of the lake from where river Sisarma enters the lake. Often found feeding in the night and roosting in the daytime in large flocks near north-western open areas of the lake. Their maximum flocks were seen during the year 1995.

*Anas poecilorhyncha* J.R. Forster  
**Spot-billed Duck**

They arrive soon after the monsoon and remains upto mid winter. Very few numbers up to 8-9 were recorded from Pichhola Lake during 1994 and 1995. They

were found feeding on weeds and rhizomes of water lilies in the shallow region of southwestern side of the lake waters.

*Anas acuta* Linnaeus

**Pintail**

It is winter visitor to this lake and seen in smaller numbers upto 7-8. They were found to feed day and night and dabbling in water frequently searching for bottom dwelling food. Their main food is tubers and rhizomes of waterweeds.

*Anas querquedula* Linnaeus

**Garganey**

A winter visitor to the lake. 2-4 birds were seen dabbling along with Common Teal in 1995 and 1996. Garganey is slightly larger than Common Teal and becomes distinct by their grey blue wing shoulders in sunlight.

*Anas clypeata* Linnaeus

**Shoveler**

It is also a winter migrant to this lake and found few in numbers. But in the year 1995 they arrived in large numbers up to 14. They prefer feeding on muddy pools around pelican corner towards southwestern shore areas of the lake often found swimming in the open waters also.

*Aythya ferina* (Linnaeus)

**Common Pochard**

A winter visitor to this lake. It is a short necked stocky duck with a large head and bill. Recorded only during 1995 winters in the lake waters near central deeps. Four birds were seen diving in open waters to feed on submerged vegetation and their seeds.

**EAGLES**

Order ACCIPITRIFORMES

Family ACCIPITRIDAE

Genus: 1, Species: 2

This is a family of eagles, the prey-birds many of them are found near wetlands as they frequently prey upon waterfowls. These raptors are huge in size and hover over large lakes/water bodies.

*Aquila clanga* Pallas  
**Greater Spotted Eagle**

This large raptor was seen frequently during winter hovering over the lake and roosting on near by forest trees around Pichhola Lake. A large size frog was once seen prey on by this bird from the open forested land margin of the lake.

*Aquila heliaca* Savigny  
**Imperial Eagle**

This raptor is larger than *Aquila clanga* observed at the lake roosting on the forested margins towards Heron embankment region and some times flying high over the lake. Most waterfowls always notice its presence and they drift to safer places. Preying on waterfowls by this bird was commonly observed.

**OSPREY**

Order ACCIPITRIFORMES

Family PANDIONIDAE

Genus : 1, Species : 1

The family Pandionidae contains a single genus *Pandion* the most widespread raptors in the world, breeding on all Continents except Antarctica and South America. Osprey eats solely fish. It circles above the water bodies watching for an unsuspecting fish just below the surface. Once a victim is sighted the bird usually hovers before plunging feet first into the water. If successful, it rises from the water in a cloud of spray with a fish struggling in its strong talons. Osprey has specially serrated talons suitable for grasping slipping hunted fish.

*Pandion haliaetus* (Linnaeus)  
**Osprey**

The Osprey is a brown and white fish-eating bird of prey. They were often seen perching on telephone poles or treetops. Before plunging in water to catch fish, they hover over the lake and plunges down, entering the water feet first to grasp the fish with its talons; then, with powerful wing beats, it bursts from the surface in a shower of spray with the fish held first in its claws. It flies powerfully away to a nearby perch.

**RAILS, GALLINULES and COOTS**

Order GRUIFORMES

Family RALLIDAE

Genus : 5, Species : 6

The Rail family comprises two main groups: the crakes and the gallinules including the coots. The Rail and Crakes are usually secretive birds. They have short rounded

wings and short erect tails. These birds have long legs and toes. The species with long bills are called rails and those with short one's as crakes. The coots are more conspicuous birds and are mostly blue or black and are more aquatic than most other members of the family with lobed toes to help them swim and dive. In the past more species of rail and coots have become extinct than in any other bird family.

*Rallus aquaticus* Linnaeus  
**Water Rail**

Its long slender red bill slightly curved at the tip distinguishes it from any other rails or crakes. They are mostly crepuscular/nocturnal in feeding and very secretive by daylight. They probe in mud or shallow muddy water and their bills are well adapted for it. The diet comprising mostly aquatic insects and their larvae. 3-5 water rails were seen in the southwestern shallow muddy area of the lake.

*Amaurornis akool* (Sykes)  
**Brown Crake**

It is roughly the same size as water Rail. It has a heavy bill, crown and upper parts are dark olive brown whilst the cheeks, breast and belly are ashy grey. They were mostly seen (3 in numbers) feeding at dawn and dusk in the shallow areas adjoining forested land in the southern margins of the lake.

*Amaurornis phoenicurus* (Pennant)  
**White-breasted Water-hen**

It is a resident bird. Found foraging at dusk and walk with constantly jerking up tails. They are solitary in feeding over vegetable matter as well aquatic crustacean and insects etc. Some 16 birds were counted in a day's time all along forested margins of western side of the lake.

*Gallinula chloropus* (Linnaeus)  
**Common Moorhen**

It is a resident bird moving more secretly in the bushy or dense margins of the lake, always avoiding the open waters. Found feeding on leaves and stems of emergent aquatic vegetation. Seen constantly flickering its tail while foraging on the muddy margins and ditches around the lake and perches on trees probably in search of food.

*Porphyrio porphyrio* (Linnaeus)  
**Purple Moorhen**

It is a winter migrant and large numbers of birds are seen in the lake, their number has been counted up to sixty-five to eighty in different years from 1994-1997. With a

bulky body and prominent purple colour with pink red legs its presence becomes prominent in the areas where submerged rhizome is in abundance. It is found feeding mostly in western side of the lake waters with more aquatic vegetation.

***Fulica atra* Linnaeus**  
**Black coot**

Coot is a winter migrant and very large concentration of these birds arrives not only at Pichhola Lake but at all other wetlands nearby. Abundantly found swimming in open waters. It is a diurnal feeder and found feeding on aquatic algae and other vegetation.

**JACANAS**

Order CHARADRIIFORMES  
Family JACANIDAE

Genus : 2, Species : 2

Jacanas are the family of shorebirds that has evolved to exploit an environment where other birds dare not tread. These lilly-trotters as they are sometimes called are the birds with very long toes to distribute their weight evenly to make them walk on water lilies. They are sedentary in habit and move locally.

***Hydrophasianus chirurgus* (Scopoli)**  
**Pheasant-tailed Jacana**

They are often seen moving on floating vegetation of *Eichhornia* and quickly moves here and there on other floating weeds in search of food. They were recorded few in numbers with as many as 17 birds around crocodile creek.

***Metopidius indicus* (Latham)**  
**Bronze-winged Jacana**

It is slightly larger than Pheasant tailed Jacana with a much heavier greenish yellow bill with a red spot at the base. It is easily recognized by its dark blue-black head and neck with broad white line extending from above the eye to around the neck. The wings are glossy bronze. Found foraging freely in association with Pheasant tailed Jacanas.

**PAINTED SNIPES**

Order CHARADRIIFORMES  
Family ROSTRATULIDAE

Genus : 1, Species : 1

The family contains colourful, secretive birds which mostly feed at dawn and dusk, but sometimes can be seen feeding in open water in the day or when flushed

from the forest cover of the lake margins. They pass their day in shade, where they sleep and preen. When flushed they fly slowly short distances with broad rounded wings and dangling legs.

*Rostratula benghalensis* (Linnaeus)

**Painted-snipe**

It is distinguished from common snipe by its slightly longer legs and short bill, slightly thickened along the distal third. Crepuscular or nocturnal feeding. It probes its bill in the mud like a snipe and continuously waggled its tail up and down like a common sandpiper. 4-7 were observed, once in open waters of the lake.

**STILTS and AVOCETS**

Order CHARADRIIFORMES

Family RECURVIROSTRIDAE

Genus : 2, Species : 2

Stilts and avocets are elegant, long-legged shorebirds found mainly in the warm temperate and tropical regions of the world. Stilts are complex group of birds with slim body and long coral pink legs and a long fine bill whereas avocets are immaculate pied birds with long, grey-blue legs and is long thin re-curved bill.

*Himantopus himantopus* (Linnaeus)

**Black-winged Stilt**

Black winged stilt is more distinctively seen due to its extremely long legs and a thin long straight black bill and white body with black wings. It is a resident bird, widely distributed all over the area and has frequent local migration. They were commonly seen wading in the shore areas of Pichhola lake feeding with fully submerged bills.

*Recurvirostra avosetta* Linnaeus

**Avocet**

Avocet is a occasional visitor to this lake and noticed in the year 1996. Eight avocets were observed in the shallow waters of the lake near open bill point feeding by their characteristic movement of the bill with side ways sweeping.

**THICK-KNEES**

Order CHARADRIIFORMES

Family BURHINIDAE

Genus : 1, Species : 1

Thick-knees are also known as stone-curlews or stone plovers in some part of the world. They are large, cryptically coloured shorebirds, recalling large plovers:

Charadriidae and found in dry open habitats. They are nocturnal and become active as the sunsets. Their food consists mainly of insects and frogs.

*Esacus recurvirostris* (Cuvier)

**Great Thick-knee or Stone Plover**

They are larger than most thick-knees, but lack the striated plumage. It has strong markings on the head and a heavy bill. Only one adult bird was seen near the northeastern side of the lake in the year 1995.

**COURSERS and PRATINCOLES**

Order CHARADRIIFORMES

Family GLAREOLIDAE

Genus: 1, Species: 1

The family Glareolidae consists of Coursers and Pratincoles. Pratincoles are more aerial members of the family, resembles large swallows as they catch insects in air.

*Glareola pratincola* (Linnaeus)

**Collared Pratincole**

They were commonly seen resting on drying out margins of the lake on the extreme western side having large hollowed grounds. They are gregarious in nature specially while hawking in air at dusk feeding on large flying insects.

**PLOVERS**

Order CHARADRIIFORMES

Family CHARADRIIDAE

Genus: 2, Species: 4

The members of the family are commonly known as Plovers. Unlike other shore birds, they are plumpish, with round heads and often a stout bill. They have a distinctive feeding pattern-run, stop, peck and run some more and repeat the same. Three species of plovers were observed at the lake.

*Charadrius dubius* Scopoli

**Little Ringed Plover**

They were observed on the margins of the lake taking swift direct flight onward than stage back to search fresh grounds. Often found feeding in areas where shallow water holds flies and dipterans larvae. It was commonly seen in areas having fewer disturbances.

***Charadrius mongolus* Pallas  
Lesser Sand Plover**

It was observed during winter in a flock foraging on the rocky shore sight around elephant rocks area adjoining wild life reserve. Few flocks were also seen on stone hill regions towards northern side of the shore area.

***Hoplopterus malabaricus* (Boddaert)  
Yellow-wattled Lapwing**

It is smaller than Red-wattled Lapwing with broad flaps of yellow fleshy skin at the base of the black tipped bill and extending below the eye. The brown breast and neck easily distinguished it from the Red-wattled Lapwing. 15-17 were sited feeding in dark on insects along the shores of the lake.

***Hoplopterus indicus* (Boddaert)  
Red-wattled Lapwing**

These birds were observed mostly singly or sometimes-in pairs on the margins of lake waters along the southern site. Their quarrelsome cries make its presence known.

**SANDPIPERS and ALLIES**

Order CHARADRIIFORMES

Family SCOLOPACIDAE

Genus : 7, Species : 10

The family Scolopacidae contains the typical shore birds or waders a widespread and diverse group of sandpipers and their allies. Within the family are a number of clearly distinguished Genus: godwits, the large shorebirds, with straight or slightly recurved bills; the curlews, with long curved bills and legs, often found in area of mud along the shores, many species have richly-coloured plumage during the breeding season. Snipes are cryptically coloured and show little or no variation in their plumage. The sandpipers are represented by several Genus with shorter bills and legs, often to be found in areas of mud.

**STINTS and RUFFS**

Subfamily CALIDRIDINAE

Genus : 2, Species : 2

***Calidris minuta* (Leisler)  
Little Stint**

Little stints were abundantly seen in flocks flying in air with a typical twist and turn with great accuracy. These wading birds feed very actively constantly searching small aquatic animals.

***Philomachus pugnax* (Linnaeus)****Ruff (and Reeve)**

The Ruff along with Reeve (female ruff) was occasionally found wading near the lakeshore. They were found feeding in less dense flocks as they are known to be probing their bills together to catch variety of animals like insects and their larvae, worms, amphipods and small molluscs.

**SNIPES**

Subfamily GALLINAGININAE

Genus: 1, Species: 1

***Gallinago gallinago* (Linnaeus)****Fantail Snipe**

Abundantly seen near the western shore end of the lake in smaller muddle pools having confined to insect larval food. They rapidly move on lake shores from side to side with high jerking flights.

**GODWITS, CURLEWS AND SANDPIPERS**

Subfamily TRINGINAE

Genus : 4, Species : 7

***Limosa limosa* (Linnaeus)****Black-tailed Godwit**

Amongst waders black-tailed godwit it is a large shore bird with long straight bill and a conspicuous white wing-bar. It was found feeding in deeper waters than other wading birds plunging its whole head and neck beneath the water surface making rapid probes alternatively with occasional deep steps. The silvery white under winged pattern with black barred upper wings flashes in sunlight during flight specially when they twist and turn in air.

***Numenius arquata* (Linnaeus)****Eurasian Curlew**

It is a large wading bird with stout body, wings and legs with slender sharp down-curved bill. 4-5 curlews were found scattered in a small area feeding by probing their bill repeatedly while walking in the shallower muddy margins all along the southern shore of the lake.

*Tringa totanus* (Linnaeus)**Common Redshank**

Red shank is winter migrant to this lake. Very few numbers were observed often in pairs with a noticeable feature of bright red legs and feet. They forage in drier areas of the lake but occasionally seen in deep waters.

*Tringa stagnatilis* (Bechstein)**Marsh Sandpiper**

It is a winter migrant to the lake but reported to over winter in near by marshy wetlands of Udaipur region. Not very gregarious in nature, very few were recorded from the lake sight graciously feeding along the water edge picking up animals on the floating objects.

*Tringa nebularia* (Gunnerus)**Greenshank**

They are larger and paler than redshank, with dark wings, a long white rump patch and green legs. It is also a winter migrant; they were found feeding singly near the forested margins towards the northeastern side of the lake.

*Tringa glareola* Linnaeus**Wood Sandpiper**

It is a most characteristic bird observed in shallow regions of lake near western shore margins. It feeds actively snapping briskly on water insects. Not many were observed at lake Pichhola.

*Actitis hypoleucos* (Linnaeus)**Common Sandpiper**

It is a smaller sandpiper with short legs. It takes low flickering flight along the water's edge and on ground it walks head up and down and wags its tail as it moves. They were found cruising over the lake frequently in large numbers up to 30-40.

**TERNs**

Order CHARADRIIFORMES

Family STERNIDAE

Genus : 1, Species : 2

Representatives of this family are known as terns. Terns are amongst the most graceful seabirds with their long wings and often a deep forked tail, they catch small fish by diving in the air. Most species are grey and white.

***Sterna aurantia* J.E. Gray**  
**Indian River Tern**

It is an oriental species confined to the Indian sub-continent. It is commonly seen in the large rivers but visits inland lakes during winter. They were commonly seen flying at Lake Pichhola during winter. Their congregation was observed to feed in a typical fashion of their own plunging sharply into the water to pick up a smaller fish and swallowing it in flight over the lake water and often roosting at intervals during the day.

***Sterna albifrons* Pallas**  
**Little Tern**

They are small birds with narrow wings and only seen during 1995 in small flocks flying rapidly at the lake. They were seen fishing in the lake both dipping to the surface and plunging deep in to the water.

**SKIMMERS**

Order CHARADRIIFORMES  
 Family RYNCHOPIDAE  
 Genus : 1, Species : 1

Skimmers have very short legs and an amazing bill. The lower half of the dark tipped red bill is longest than the upper half and has evolved to accommodate the unusual method of feeding adopted by Skimmers. There is a series of curved grooves to counteract the tendency while skimming for the bill to be pushed downward in the water.

***Rynchops albicollis* Swainson**  
**Indian Skimmer**

It gives an appearance of a crow. The bill is long, strongly arched downwards on the culmen and coloured dark orange with a yellow tip. They feed at dusk and dawn on small insects and their larvae. They also forage by flying steadily and slowly along the edge of the lake to catch a fish. They fly low and deliberately over smooth water with the bill wide open and the lower mandible slicing the surface like a knife. As soon as a fish is detected the head jerks downward as the mandibles close to secure the prey. The bird raises its head once more, swallows the fish and carries on skimming. The action is instantaneous and does not interrupt the level of flight path.

**KINGFISHERS**

Order CORACIIFORMES  
 Family ALCEDINIDAE  
 Genus : 3, Species : 3

This family is represented by kingfishers-chunky birds that appear somewhat reckless, with large heads and stout bills. They feed mainly on fish and some eat reptiles and insects.

***Halcyon smyrnensis* (Linnaeus)  
White-breasted Kingfisher**

This species is smaller than lesser-pied kingfisher with heavier bill, broader and flattened at the base, other than its difference in body colour. It is a resident bird. It was found perching over dry land on a post or a dead tree or near water from where it watches its prey and dive down at an angle to catch it. Though it has been reported feeding on variety of animals but at Pichhola Lake it was found preying on fishes or large-sized insects. There numbers observed were 7-10.

***Alcedo atthis* (Linnaeus)  
Common Kingfisher**

It is a very small kingfisher with a short stumpy tail. It was also found perching on dead trees or posts specially his favourite perching place on unused tourists boats and drop to the ground to catch the prey. Not many were observed but their population was around 20-25.

***Ceryle rudis* (Linnaeus)  
Lesser Pied Kingfisher**

The characteristic habit of hovering over water makes its presence known. It has a comparatively massive head, short neck and stumpy tail. They were frequently seen fishing in the lake during day time near angle's bed. This species was seen in large numbers.

## RESULTS AND DISCUSSION

Arrival of guests has always been welcomed and considered a sign of prosperity. It is true with most wetlands inviting large number of waterfowls, shore and upland birds to not only over winter, forage and breed but also protects them. However, with the advent of human development these creations of the nature are exploited to the extent that their true dependents are getting deprived of the resources. If you find a wetland with diverse species of waterfowls, waders, shoreline and upland birds, it is assured that wetland is still in good health. Of course, their population may vary depending upon habitat utilization factors and the stage of health at which a wetland is surviving. Pichhola Lake is one such wetland of National Importance whose avian species diversity is very high, although the population varies greatly.

Wetlands have always been considered and are popularly known as waterfowl habitats. However, by no means, these aquatic ecosystems are restricted only to waterfowls but also harbour shore and uplands birds. Although, birds of family Anatidae are only considered as waterfowls (Finn, 1985), but the Wetland International under Asian Wetland Census is counting all the aquatic birds including waders, shoreline and upland birds as waterfowls.

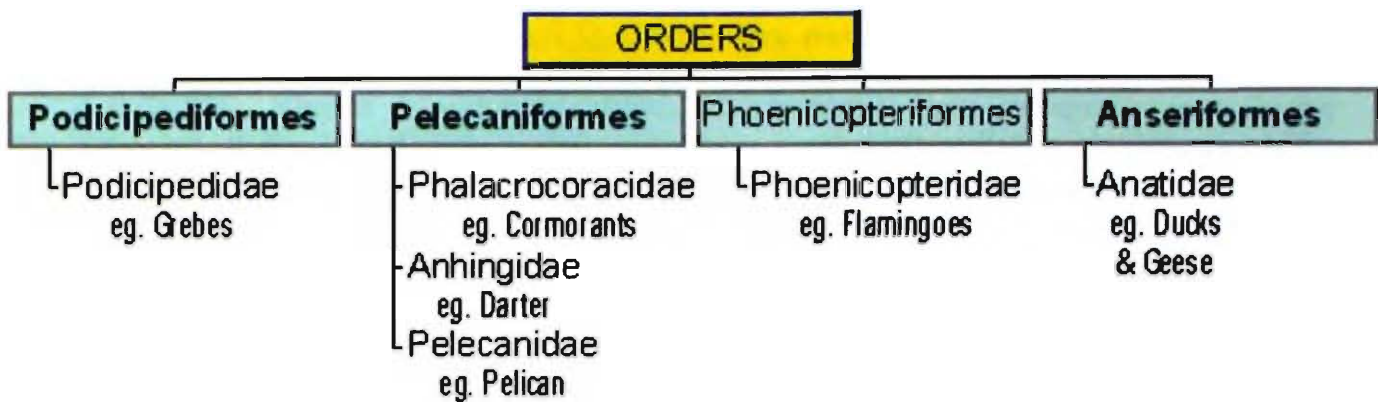


Fig. 1 : Taxonomic Status of Waterfowls of Pichhola Lake.

In the present paper, the avian diversity of Pichhola Lake has been divided into two main groups and their taxonomic status has been illustrated (Fig. 1. and 2.). The paper reports 71 species belonging to 51 Genus under 22 families. Waterfowls, shore and upland birds of Pichhola Lake include an array of species that for the most part require wetland habitat. The waterfowl encompasses birds like Grebes, Cormorants, Darters, Pelicans, Flamingoes and Anatids. The shore and upland birds includes

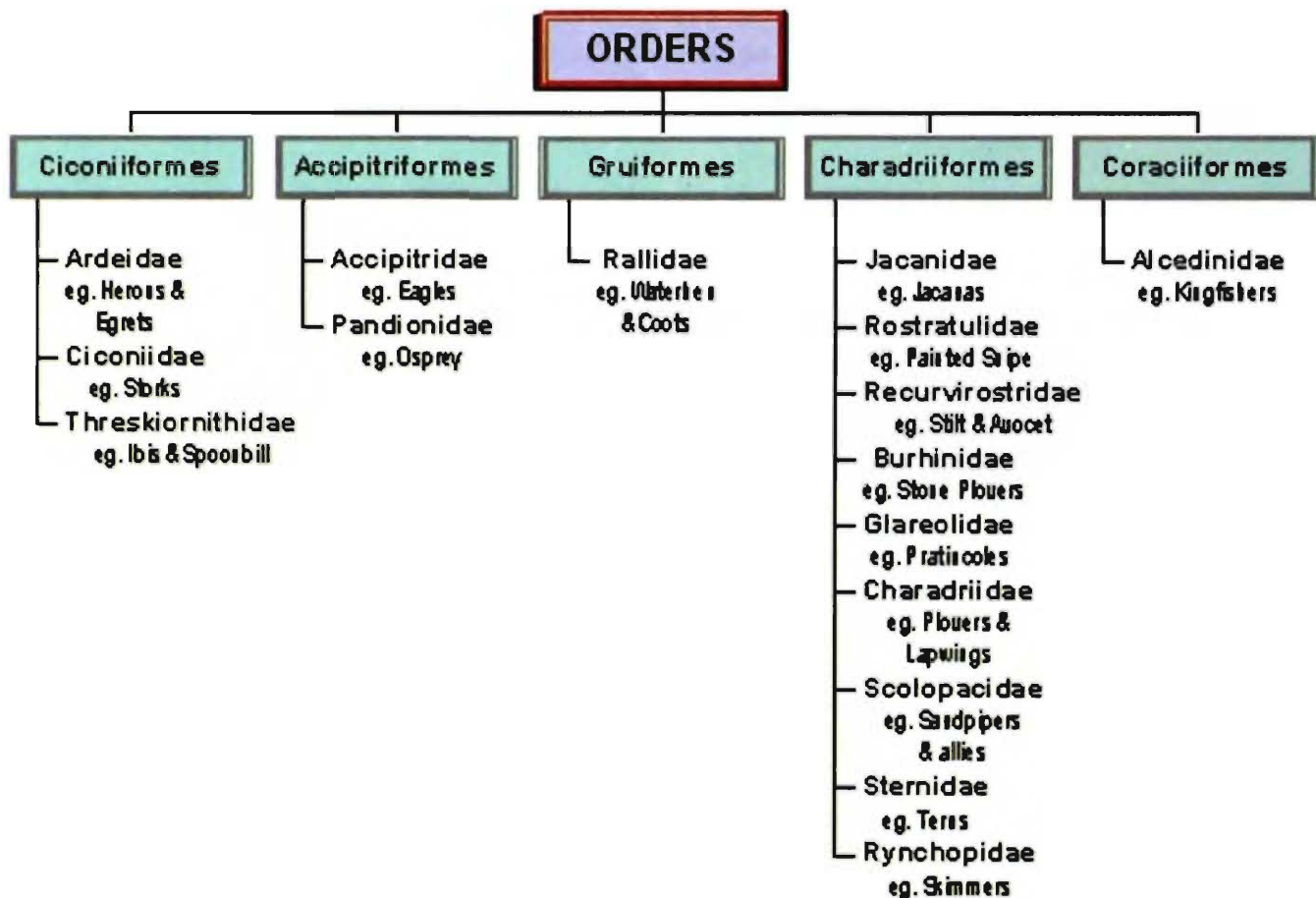


Fig. 2 : Taxonomic Status of Shore and Upland birds of Pichhola Lake

Hérons, Storks, Ibis and Spoonbills, birds of prey-Eagles and Osprey, Rails, Crakes, Waterhens and Coots, Jacanas, Snipe, Stilts and Avocets, Stone-curlews, Pratincoles, Plovers and Lapwings, Sandpipers and allies, Terns, Skimmers and Kingfishers.

Among the species of birds found at Pichhola Lake, some are seldom seen, some hunted but all are enjoyed aesthetically. Many of the species are resident and some are migratory (Table-1). Waterfowls, shore and upland birds have many needs. Shorelines, shallow muddy areas and open water habitats are important for these species. Shorebirds rests near water. Surface feeding ducks paddle, dabbling and diving grebes and ducks are found in shallow and open waters, whereas upland birds hover over the lake and occasionally dive in water for food (Fig. 3).

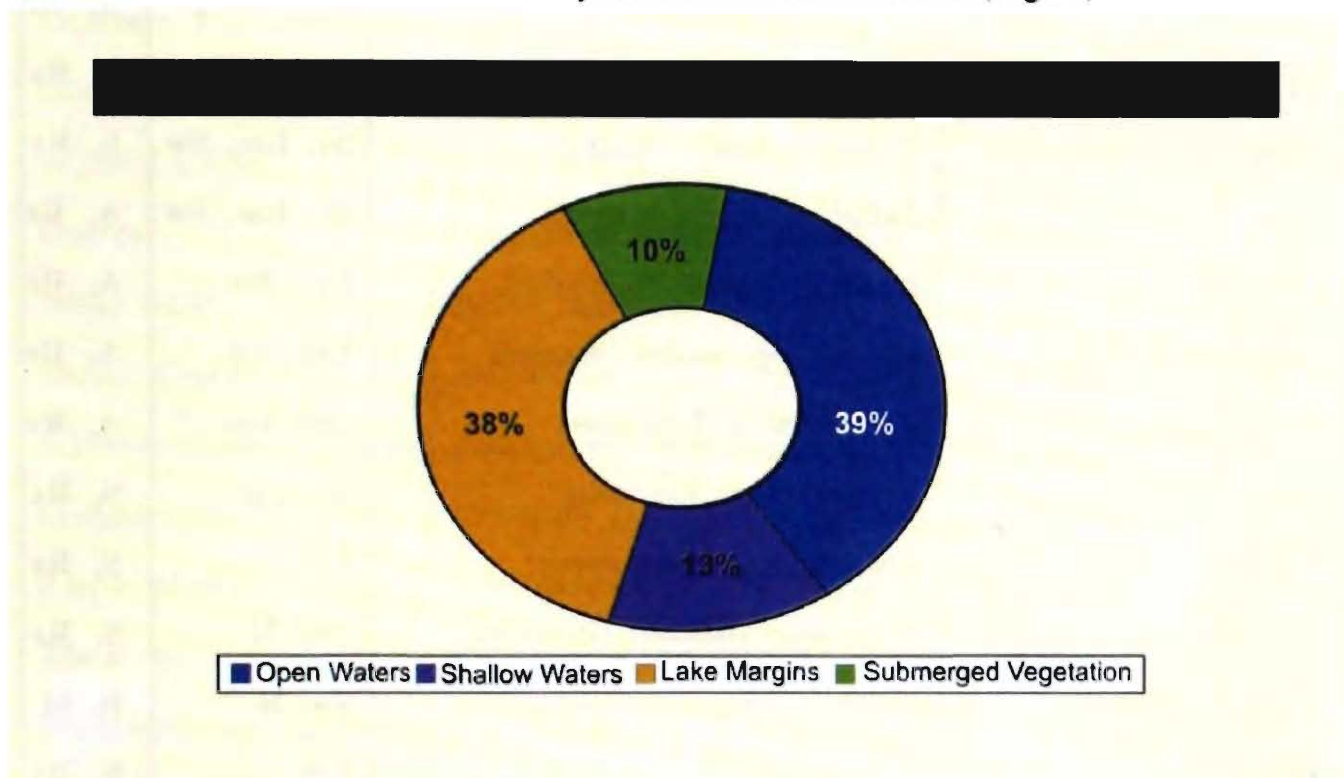


Fig. 3 : Habitat preference of wetland avifauna of Pichhola lake.

**Table 1.** : List of waterfowl, shore and upland birds recorded during 1994 1997 at Pichhola Lake.

Common Name	Scientific Name	Habitat	Status
Little Grebe	<i>Tachybaptus ruficollis</i> (Pallas)	Ow	S, Re
Great Crested Grebe*	<i>Podiceps cristatus</i> (Linnaeus)	Ow	R, M
Black necked Grebe*	<i>Podiceps nigricollis</i> C.L. Brehm	Ow	S, M
Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus),	Ow, B	A, Re

Common Name	Scientific Name	Habitat	Status
Indian Shag	<i>Phalacrocorax fuscicollis</i> Stephens	Ow	A, Re
Little Cormorant	<i>Phalacrocorax niger</i> (Vieillot)	Ow, B	A, Re
Darter	<i>Anhinga rufa</i> (Daudin)	Ow, B, Lm	A, Re
White or Rosy Pelican	<i>Pelecanus onocrotalus</i> Linnaeus	Ow	Vr, M
Great Bittern*	<i>Botaurus stellaris</i> (Linnaeus)	Lm	R, Re
Yellow Bittern*	<i>Ixobrychus sinensis</i> (Gmelin)	Lm	R, Re
Night Heron	<i>Nycticorax nycticorax</i> (Linnaeus)	Lm	S, Re
Indian Pond Heron	<i>Ardeola grayii</i> (Sykes),	Sv, Lm, Sw	S, Re
Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus)	Sv, Lm, Sw	A, Re
Little Egret	<i>Egretta garzetta</i> (Linnaeus)	Lm, Sw	A, Re
Intermediate Egret	<i>Egretta intermedia</i> (Wagler)	Lm, Sw	A, Re
Large Egret	<i>Egretta alba</i> (Linnaeus)	Ow, Lm	A, Re
Grey Heron	<i>Ardea cinerea</i> Linnaeus	Sv, Lm	S, Re
Purple Heron	<i>Ardea purpurea</i> Linnaeus	Lm	S, Re
Openbill Stork	<i>Anastomus oscitans</i> (Boddaert)	Ow, H	S, Re
White necked Stork	<i>Ciconia episcopus</i> (Boddaert)	Sw, H	R, M
Glossy Ibis	<i>Plegadis falcinellus</i> (Linnaeus)	Lm,	S, Re
Black Ibis	<i>Pseudibis papillosa</i> (Temminck)	Lm	S, Re
White Spoonbill	<i>Platalea leucorodia</i> Linnaeus	Ow, H	S, M
Greater Flamingo*	<i>Phoenicopterus ruber</i> Linnaeus	Ow, Sw	Vr, M
Lesser Whistling Teal	<i>Dendrocygna javanica</i> (Horsfield)	Ow	R, Re
Indian Cotton Teal*	<i>Nettapus coromandelianus</i> (Gmelin)	Ow	A, Re
Ruddy Shelduck	<i>Tadorna ferruginea</i> (Pallas)	Ow	S, M
Wigeon	<i>Anas penelope</i> Linnaeus	Ow	S, M
Gadwall	<i>Anas strepera</i> Linnaeus	Ow	R, M

Common Name	Scientific Name	Habitat	Status
Common Teal	<i>Anas crecca</i> Linnaeus	Ow	A, M
Spot-billed Duck	<i>Anas poecilorhyncha</i> J. R. Forster	Ow	S, M
Pintail	<i>Anas acuta</i> Linnaeus	Ow	R, M
Garganey	<i>Anas querquedula</i> Linnaeus	Sw, Ow	A, M
Shoveler	<i>Anas clypeata</i> Linnaeus	Ow	R, M
Common Pochard	<i>Aythya ferina</i> (Linnaeus)	Ow	Vr, M
Greater Spotted Eagle	<i>Aquila clanga</i> Pallas	Lm	S, Re
Imperial Eagle	<i>Aquila heliaca</i> Savigny	Lm	S, Re
Osprey	<i>Pandion haliaetus</i> (Linnaeus)	Ow	S, Re
Water Rail*	<i>Rallus aquaticus</i> Linnaeus	Sw	R, M
Brown Crane*	<i>Amaurornis akool</i> (Sykes)	Sw, Lm	Vr, Re
White-breasted water-her	<i>Amaurornis phoenicurus</i> (Pennant)	Lm	R, Re
Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus)	Ow, Sv	A, Re
Purple Moorhen	<i>Porphyrio porphyrio</i> (Linnaeus)	Ow, Lm, Sv	A, M
Black coot	<i>Fulica atra</i> Linnaeus	Ow	A, M
Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> (Scopoli)	Lm, Ow	R, Re
Bronze-winged Jacana*	<i>Metopidius indicus</i> (Latham)	Lm, Ow	R, Re
Painted snipe*	<i>Rostratula benghalensis</i> (Linnaeus)	Ow, Sw	R, Re
Black-winged Stilt	<i>Himantopus himantopus</i> (Linnaeus)	Lm, Sv	S, Re
Great Thick-knee*	<i>Esacus recurvirostris</i> (Cuvier)	Lm, Sw	R, M
Pied Avocet	<i>Recurvirostra avosetta</i> Linnaeus	Sv, Lm, Sw	Vr, M
Collared Pratincole	<i>Glareola pratincola</i> (Linnaeus)	Lm, Sv	S, M
Little Ringed Plover	<i>Charadrius dubius</i> Scopoli	Lm, Sv	S, Re
Lesser Sand Plover	<i>Charadrius mongolus</i> Pallas	Lm, Sv	S, M

Common Name	Scientific Name	Habitat	Status
Yellow-wattled Lapwing*	<i>Hoplopterus malabarius</i> (Boddaert)	Lm	S, Re
Red-Wattled Lapwing	<i>Hoplopterus indicus</i> (Boddaert)	Lm	S, Re
Little Stint	<i>Calidris minuta</i> (Leisler)	Lm	R, M
Ruff (and Reeve)	<i>Philomachus pugnax</i> (Linnaeus)	Ow	R, M
Fantail Snipe	<i>Gallinago gallinago</i> (Linnaeus)	Ow	S, M
Black-tailed Godwit	<i>Limosa limosa</i> (Linnaeus)	Ow	S, M
Eurasian Curlew*	<i>Numenius arquata</i> (Linnaeus)	Sw, Lm	S, M
Common Redshank	<i>Tringa totanus</i> (Linnaeus)	Lm	S, M
Marsh Sandpiper	<i>Tringa stagnatilis</i> (Bechstein)	Lm	S, M
Green Shank	<i>Tringa nebularia</i> (Gunnerus)	Lm	S, M
Wood Sandpiper	<i>Tringa glareola</i> Linnaeus	Lm	A, M
Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus)	Lm	A, M
Indian River Tern	<i>Sterna aurantia</i> J.E. Gray	A	A, Re
Little Tern	<i>Sterna albifrons</i> Pallas	A	S, Re
Indian Skimmer*	<i>Rynchops albicollis</i> Swainson	Sw, Ow	S, Re
White-throated Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus)	Lm, Ow	A, Re
Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus)	Lm, Ow	A, Re
Lesser Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus)	Lm, Ow	S, Re

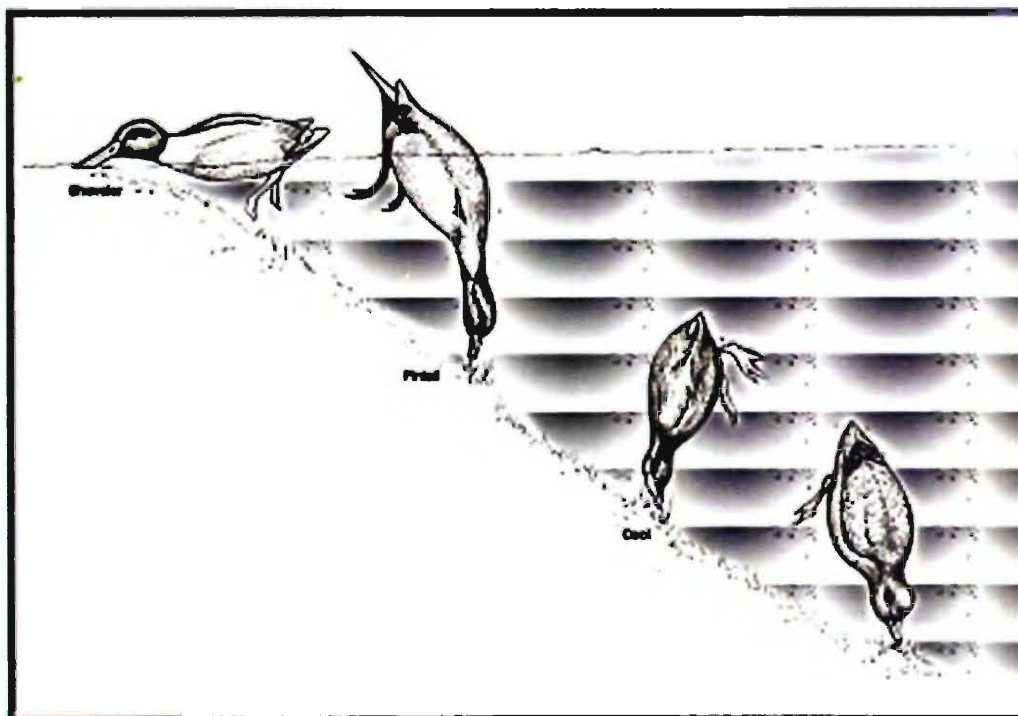
Ow=Open water, Sw=Shallow water, Lm=Lake margins, Sv=Submerged vegetation, H=Heronry, B=Buildings, A=Abundant, S= Sizeable, R=Rare, Vr=Very rare, Re = Resident M = Migrant and \* New records.

The bills of many waterfowls and shore birds specially waders are adapted to utilize different sections of the shallow waters: some probe the mud bottom, some utilize the benthic fauna near the surface and other catch small fish or other organic material floating in the water column. Cormorants, Pelicans, Pintails, Shovelers and Teals ply the shallow waters. Herons and Spoonbills have dagger-like bills and they wade on the shallow margins of the lake.

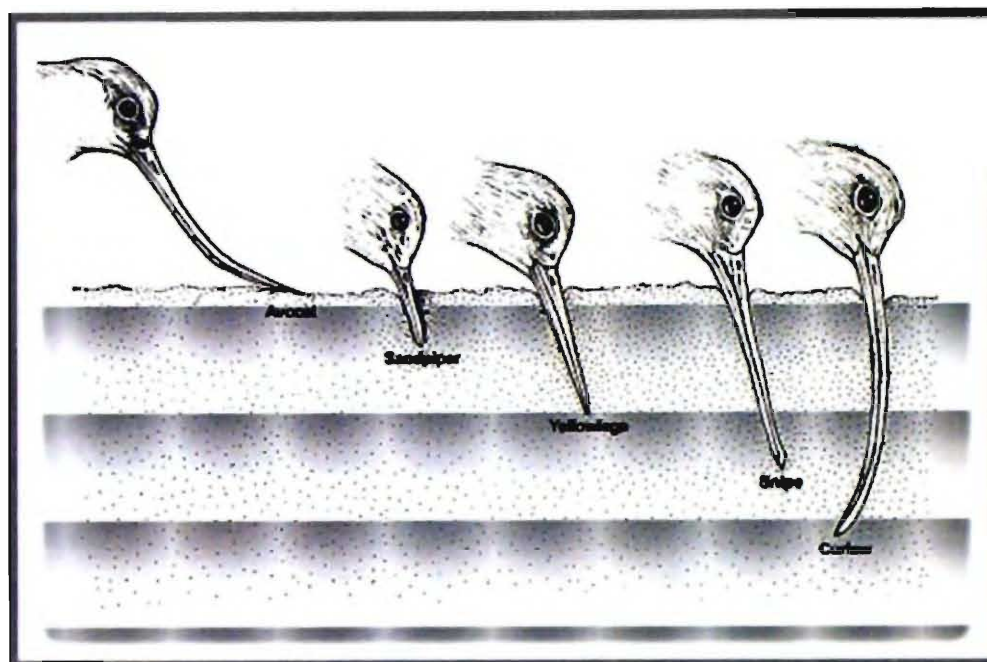
The legs of aquatic birds are also accordingly modified to utilize different habitat zone of the lake. The shorebirds (waders) have very long legs enabling them to wade into deep waters in search of food. Flamingo's legs are extremely long, indicating that it feeds by wading in deep waters. Flamingos feed in deep water, but they are quite capable of swimming and even regularly up-end, duck-like to reach the bottom to feed. Other waterfowls, shore and upland birds also have highly specialized food or feeding techniques and legs peculiarly adapted accordingly like Ospreys have specially serrated talons suitable for grasping slippery fish, which they hunt by swooping down to the surface of the water from the air.

Birds congregate in a few food rich areas, the species rarely mingle, but rather gather by species into smaller flocks and their varied feeding habitat makes them utilize the food available at different depths of water in the lake thereby eliminating competition among themselves (Plate 1). The wading birds are mostly seen in areas where the waters are full of fishes and other food. The variable shape and length of water bills enable them to feed at different depths and on different foods within their muddy habitat (Plate 2). Thus, the bill-foot combination enable these wetland birds to have maximum utilization of habitat resources.

The birds exhibit what is known as "resource partitioning" as they feed i.e. each species hunts in unique way or place, thus avoiding direct competition with other species. The partitioning has a lot to do with bills. The long billed curlew with its extraordinarily curved beak can probe very deep into the mud for food that is beyond the reach of other birds. While sandpiper's stay at the upper layers and wade into shallow water to hunt (Plate 2).



**Plate 1** : Different feeding levels of aquatic birds showing resource partitioning at Pichhola Lake



**Plate 2 :** Different feeding profiles of muddy water zones of wetland birds showing resource partitioning at Pichhola Lake

Conservation efforts on behalf of these birds should aim at maintaining the lake pollution free. The normal level of water must be maintained: each species has evolved characteristics, the bill in particular to probe the water or mud below the water for food, therefore, fluctuating water level can be distressing. Their areas should also be protected from grazing, extensive recreational use and development. Public living around the lake Pichhola should be made aware not to disturb these birds. As a matter of fact some eighteen wetland species of birds *viz.* Grey Pelican, Little Green Heron, Pond Heron, Painted stork, White Ibis, Barheaded Goose, White-eyed Pochard, Tufted Pochard, Eastern Common Crane, Sarus Crane, Demoiselle Crane, Kentish Plover, Green Sandpiper, Jack snipe, Temminck's Stint, Stone Curlew, Great stone Curlew and Gullbilled Tern earlier recorded were not sighted during the present study period may be due to imbalance in the habitat ecology or environmental aversion.

### SUMMARY

The paper reports 71 species belonging to 51 Genus under 22 families. Management of the lake Pichhola should involve a combination of techniques. Essentially the area must have an adequate food supply to attract waterfowl, shore and upland birds. These areas must be evaluated in light of desired species needs. A good management is primarily that of maintaining adequate habitat diversity. It is very important to keep these areas free from pollution, human and predator disturbance. Birds are the most mobile animals on earth and therefore their conservation has to be approached on an International scale.

### ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India, Kolkata and the Officer-In-charge, Desert Regional Station, ZSI, Jodhpur for providing facilities to carry out this work. Thanks are also due to Shri Raza Tehsin, Udaipur and Shri Mahendra Singh Lalas, Udaipur for personal communication and various suggestions during the study period.

### REFERENCES

- Ali, Salim and Ripley, S.D. 1983. Birds of India and Pakistan. Oxford University Press, Oxford : 1-733.
- Anonymous. Birds and Fishes of Lake Palace (Pichhola), Udaipur. Published by Lake Palace Hotels and Motels Pvt., Udaipur-India.
- Roberts, T. J. 1991. Birds of Pakistan. Non-passeriformes. Vol. I. Oxford University Press, New York : 1-598.
- Woodcock, Martin W. 1983. Collins Handguide to the birds of the Indian Sub-Continent. Printed by Wm Collins Sons and Co Ltd, Glasgow : 1-170.

## Chapter 12

# Mammalia



S. Kumar and N.S. Rathore



photo : S. Kumar

A Jungle Cat

## MAMMALIA

S. KUMAR AND N.S. RATHORE

Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan

### INTRODUCTION

Our knowledge on mammals of Rajasthan is available from the studies made by Alfred and Agrawal (1996), Agrawal (1967), Bahadur (1925), Bate and Harrison (1997), Biswas and Ghosh (1968), Ghosh (1976), Prakash (1959, 1974, 1975 and 1995) and Roberts (1977). Sharma (1995 and 1999) has documented 87 species of mammals belonging to 55 genera under 27 families from the state of Rajasthan along with their district and region-wise distribution within the state. But there is very little account of mammalian fauna found near or associated with the wetlands of Rajasthan. Some works are that of Haque and Vijayan (1988), Sharma (1995) and Kumar (2005) who have reported *Vulpes vulpes pusilla*, *Herpestes edwardsi ferrugineus*, *Lutra perspicillata sindica*, *Platinista gangetica*, *Felis viverrina*, *Felis silvestris ornate*, *Boselaphus tragocamelus*, *Funambulus pennanti* and *Tatera indica indica*.

The present account enlists ten mammalian species found around the Pichhola Lake in Udaipur. The species were mainly observed during 1994-1997 while undertaking the faunal survey of Pichhola Lake. The classification followed is after Ellerman and Morrison-Scott (1951), Honaki *et al.* (1982) and Alfred, *et al.* (2002).

### SYSTEMATIC ACCOUNT

Class MAMMALIA  
Order CHIROPTERA  
Family PTEROPODIDAE  
Subfamily PTEROPODINAE  
Genus *Pteropus* Erxleben, 1777  
*Pteropus giganteus* (Brunnich)  
Indian Flying Fox.

1782. *Verpertilio giganteus* Brunnich, *Dyreness Historie*, 1 : 45 (Bengal = West Bengal, India).

**Diagnosis** : Very large size probably largest bat in India, brightly coloured with orange coloured band across the upper back. Head long with dog like muzzle. No tail present.

**Distribution** : Widely distributed throughout India including Andamans.

**Elsewhere** : China, Thailand, Pakistan, Sri Lanka, Nepal, Bangladesh, Maldiv Islands and Myanmar.

**Remarks** : Gregarious, roosts mainly in large trees near the lake. A colony of < 100 individuals were observed on trees at south-western forested margin of the lake. Often seen in thousands hovering over the lake especially on cloudy evenings.

Order PRIMATES  
Family CERCOPITHECIDAE  
Subfamily COLOBINAE

Genus *Semnopithecus* Desmarest, 1822

*Semnopithecus entellus* (Dufresne)  
**Hanuman Langur**

1797. *Simia entellus* Dufresne, *Bull. Soc. Philom Paris* 1, 7 : 49 (Bengal).

**Diagnosis** : Large-sized body with black face, tail longer than head and body. Upper side brown, hands and feet black-palebrown with contrasting colour of arms and legs. Short whiskers cover the ears.

**Distribution** : India : Throughout the country except NE India and Western part of Gujarat. Bihar, Delhi, Haryana, Madhya Pradesh, Orissa, Punjab, Rajasthan (except extreme west), Uttar Pradesh, West Bengal.

**Elsewhere** : China, Nepal, Pakistan, Bangladesh and Sri Lanka.

**Remarks** : Small groups of 5-7 were observed in the forested area around Pichhola Lake. Their frequent movement within the forested area is noticeable and seen feeding on the fruit trees of the region.

Order CARNIVORA  
Family HERPESTIDAE  
Subfamily HERPESTINAE

*Herpestes edwardsii ferrugineus* Blanford  
**Indian Grey Mongoose**

1874. *Herpestes ferrugineus* Blanford, *Proc. zool. Soc. Lond.*, : 661 (Larkhana, Sind, Pakistan).

**Diagnosis** : Pale gray grizzled body with reddish brown speckling, face sharply conical with small ears concealed beneath the body, hind foot distinctly reddish.

**Distribution** : India : Throughout India. Gujarat, Rajasthan, Himachal Pradesh.

**Elsewhere** : Afganistan, Bahrain, Indonesia, Pakistan, Iraq, Iran, Japan, Kuwait, Malaysia, Nepal, Saudi Arabia and Sri Lanka.

**Remarks** : Commonly seen adjacent to the forested margins especially on the south-western to south-eastern side of the lake.

Family FELIDAE  
Subfamily FELINAE

Genus *Felis* Linnaeus, 1758

*Felis chaus kutas* Pearson  
Jungle Cat

1832. *Felis kutas* Pearson, *J. Asiat. Soc. Bengl.*, 1 : 75 (Medinapur, West Bengal, India).

**Diagnosis** : Unspotted dorsal pelage, black horizontal stripes present on the inner side of fore legs, Underside reddish, fore throat, axillae and groin white.

**Distribution** : India : South of Krishna river in South india, Bihar, Gujarat, Madhya Pradesh, Orissa, Rajasthan, Jammu & Kashmir, Sikkim, Uttar Pradesh and West Bengal.

**Elsewhere** : Afganistan, Algeria, Arabia, benin, China, Egypt, Iran, Iraq, Israel, Kenya, Malawi, Morocco, Mojambique, Myanmar, Nepal, Pakistan, Sri Lanka, Syria, Thialand, Vietnam, Yemen, Zambia, Zimbabwe and CIS countries.

**Remarks** : Occasionally seen in the forested land margins of the lake especially during day time when fishermen's are staking the fishes near the open areas of the lake loading the material in trucks for sale.

Order ARTIODACTYLA  
Family SUIDAE  
Subfamily SUINAE

Genus *Sus* Linnaeus, 1758

*Sus scrofa cristatus* Wagner  
Indian Wild Boar

1839. *Sus cristatus* Wagner, *Munch. Gelehrt. Anz.* 9 : 35 (probably Malabar Coast, India).

*Diagnosis* : Females smaller than males. Body with short thick neck and slender legs. Head with sloping muzzle, large ears and small eyes. Body colour varies from dark gray to pinkish brown with coarse black and brown bristles. Tusk like canine developed in adult males.

*Distribution* : Throughout forested or semi-forested tracts of whole of India.

*Elsewhere* : Australia, China, U.S.A, Central and South America, Europe, Norway, Sweden, South Russia to middle east, Pakistan, South Africa, Sri Lanka, Nepal, Bangladesh, Fiji Islands, Galapagos, Hawain Islands, Myanmar, Indonesia, Lesser Sunde Islands, Solomon Islands, Mauritius, Molucca Islands, Malaysia West Indies and Vietnam.

*Remarks* : Sizeable population dwells inside the game reserve of the erstwhile Maharaja of Mewar adjoining the lake Pichhola and occasionally seen coming to the southern side of the lake margins in the cultivated fields or swampy portion surrounded by forest. Due to their unchecked killing and affect of pesticide use in agriculture cultivation is bringing down their number drastically.

Family BOVIDAE  
Subfamily ANTILOPINAE

Genus *Gazella* Blainville, 1816

*Gazella bennetti* (Sykes)  
Indian Gazelle / Chinkara

1831. *Antilope bennetti* Sykes, *Proc. zool. Soc. Lond.*, 1830-31 : 104 (Deccan, India).

*Diagnosis* : Medium sized with slender body and short black tail. Horns of females much smaller than males. Tuft of long hairs on each knee.

*Distribution* : India: Andhra Pradesh, Gujarat, Karnataka, Madhya pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and Rajasthan.

*Elsewhere* : E. Iran to Pakistan.

*Remarks* : Occasionally seen near the water towards the boundary of the enclosed area of game reserve. Small population is present in the area.

Genus *Antilope* Pallas, 1766

*Antilope cervicapra* (Linnaeus)  
Black Buck

1758. *Capra cervicapra* Linnaeus, *Syst. Nat.*, 10<sup>th</sup> ed., 1 : 69 (Inland of Trivandrum, Kerala, India).

**Diagnosis** : Male and Female distinct. Body medium and robust. Male bears spirally twisted long, slender horns with rounded transverse ridges and black dorsally. Females reddish dorsally and hornless.

**Distribution** : India : Punjab, Rajasthan, Gujarat, Bihar, Assam in the east and up to Kanyakumari in south.

**Elsewhere** : Pakistan. Introduced population in Nepal, Texas (U.S.A.) and Argentina.

**Remarks** : A sizeable population is present in the enclosed area under game reserve of the erstwhile Mewar Estate adjoining the lake Pichhola. The low boundary wall allows these animals to some times come out of the enclosed area. Its population in the hill slopes around Pichhola Lake is scatteredly available but does not extend to the lake region due to human habitation belt around the wetland except the game reserve area.

Order LAGOMORPHA

Family LEPORIDAE

Genus *Lepus* Linnaeus, 1758

*Lepus nigricollis dayanus* Blanford  
Indian Hare

1874. *Lepus dayanus* Blanford, *Proc. zool. Soc.*, 663 (Sukkur, Sind, Pakistan).

**Diagnosis** : Dorsal fur short, dorsum pale brown, nape of the neck buff, lower limbs ochraceous, throat and chest creamish yellow and lower belly up to inguinal region whitish.

**Distribution** : India : Gujarat, Rajasthan and Punjab.

**Elsewhere** : Bangladesh, Bhutan, Indonesia, Pakistan and Sri Lanka.

**Remarks** : Commonly found in the forested land margins of the lake Pichhola and adjacent cultivated foothill slopes around the lake. Variation in their length and shade of the coat was noticed may be due to age and moulting process.

Order RODENTIA

Family SCIURIDAE

Subfamily SCIURINAE

Genus *Funambulus* Lesson, 1835

*Funambulus pennantii* Wroughton  
Five-striped Palm Squirrel

1905. *Funambulus pennantii* Wroughton, *J. Bombay nat. Hist. Soc.*, 16 : 411 (Mandvi Taluka, Surat, Gujarat, India).

*Diagnosis* : Small in size, ears rounded, and muzzle pointed. Dorsum grey and divided by three cream coloured stripes and distinctly separated from belly by indistinct creamy buff longitudinal strip. Tail bushy with whitish or creamy tip.

*Distribution* : India : Andaman Islands, Assam, Bihar, Delhi, Gujarat, Haryana, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Sikkim, Uttar Pradesh, West Bengal.

*Elsewhere* : Afganistan, Pakistan, Iran, Nepal and Bangladesh.

*Remarks* : Most commonly found around Pichhola Lake in abandoned buildings inside forested zone and every other possible human habitation in and around wetland.

Family MURIDAE

Subfamily MURINAE

Genus *Rattus* Fischer, 1803.

*Rattus rattus* (Linnaeus)

**House Rat or Black Rat**

1758. *Mus rattus* Linnaeus, *Syst. Nat.*, 10<sup>th</sup>., 1, 61. From Uppsala, Sweden.

*Diagnosis* : Medium size, belly white, tails dark in colour and longer than head and body.

*Distribution* : India : Throughout Indian Territory including Andaman Islands.

*Elsewhere* : South China and Malay Islands. Introduced world wide in the tropics and temperate zones.

*Remarks* : The species was frequently encountered in good numbers around abundant buildings in the forested land margins of Pichhola lake. One example of this species was trapped accidentally but released.

## SUMMARY

The paper records the sighting of ten species of mammals belonging to six orders under nine families. The mammalian species reported are abundantly found in the forested belt around Pichhola Lake including the adjacent area enclosed by Erstwhile Maharaja Rao Virender Singh ji of Mewar as Game Reserve. These animals are partially or substantially depended on Lake Pichhola for various needs and remain closely associated with the wetland.

### ACKNOWLEDGEMENTS

Authors are thankful to Dr. R.A. Khan, Director-In-charge and Dr. J.R.B. Alfred, Ex-Director, Z.S.I., Kolkata and the Officer-in-charge, D.R.S., Z.S.I., Jodhpur for providing facilities. Gratitude is expressed towards Late Prof. Ishwar Prakash for giving useful suggestions to improve the quality of this communication. Thanks are also due to Shri Raja Tehsin, Udaipur for confirming our observations and supplementing information on mammals of this region.

### REFERENCES

- Agrawal, V.C. 1967. New mammal records from Rajasthan. *Labdev J. Sci. Tech.*, Kanpur, **5** : 342-344.
- Alfred, J.R.B. and Agrawal, V.C. 1996. The mammal diversity of the Indian Desert. In: *Faunal Diversity in the Thar Desert, Gaps in Research*, (Ed. A.K. Ghosh, Q.H. Baqri, I. Praksh). Scientific Publishers Jodhpur : 335-348.
- Alfred, J.R.B., Sinha, N.K. and Chakraborty, S. 2002. Checklist of Mammals of India, *Rec. zool. Surv. India, Occ. Paper No.*, **199** : 1-289. (Published by the Director, *Zool. Surv. India*, Kolkata).
- Bahadur, S.S. 1925. A hybrid black buck (*A. cervicapra*) and Chinkara (*G. bennetti*). *J. Bombay nat. hist. Soc.*, **30**(4) : 922-912.
- Bate. J.J. Paul and Harrison, David L. 1997. *Bats of the Indian subcontinent* : 9-13. Published by Harrison Zoological Museum : i-xvi + 1-258.
- Biswas, B. and Ghosh, R.K. 1968. New record of mammals from Rajasthan, India. *J. Bombay nat. Hist. Soc.*, **65** : 481-482.
- Ellerman, J.R. and T.C.S. Morrison-Scott. 1951. Checklist of Palearctic and Indian mammals, 1758-1946. *Br. Mus. Nat. Hist.*, London : 1-810.
- Ghosh, R.K. 1976. Further new records of mammals from Rajasthan, India. *J. zool. Soc. India*, **26** : 149-150.
- Haque, M.N. and Vijayan, V.S. 1988. Food habits of the smooth Indian otter (*Lutra perspicillata*) in Keoladeo National Park, Bharatpur, Rajasthan. First International Asian Otter Symposium, Bangalore. October 1988. Abstract. *Asian Otter Specialist Group Newsletter*, **1** : 17.
- Honacki, J.H., Kirman, K.E. and Koepl, J.W. 1982. Mammal species of the world. Allen Press Inc. Kanasa, USA.

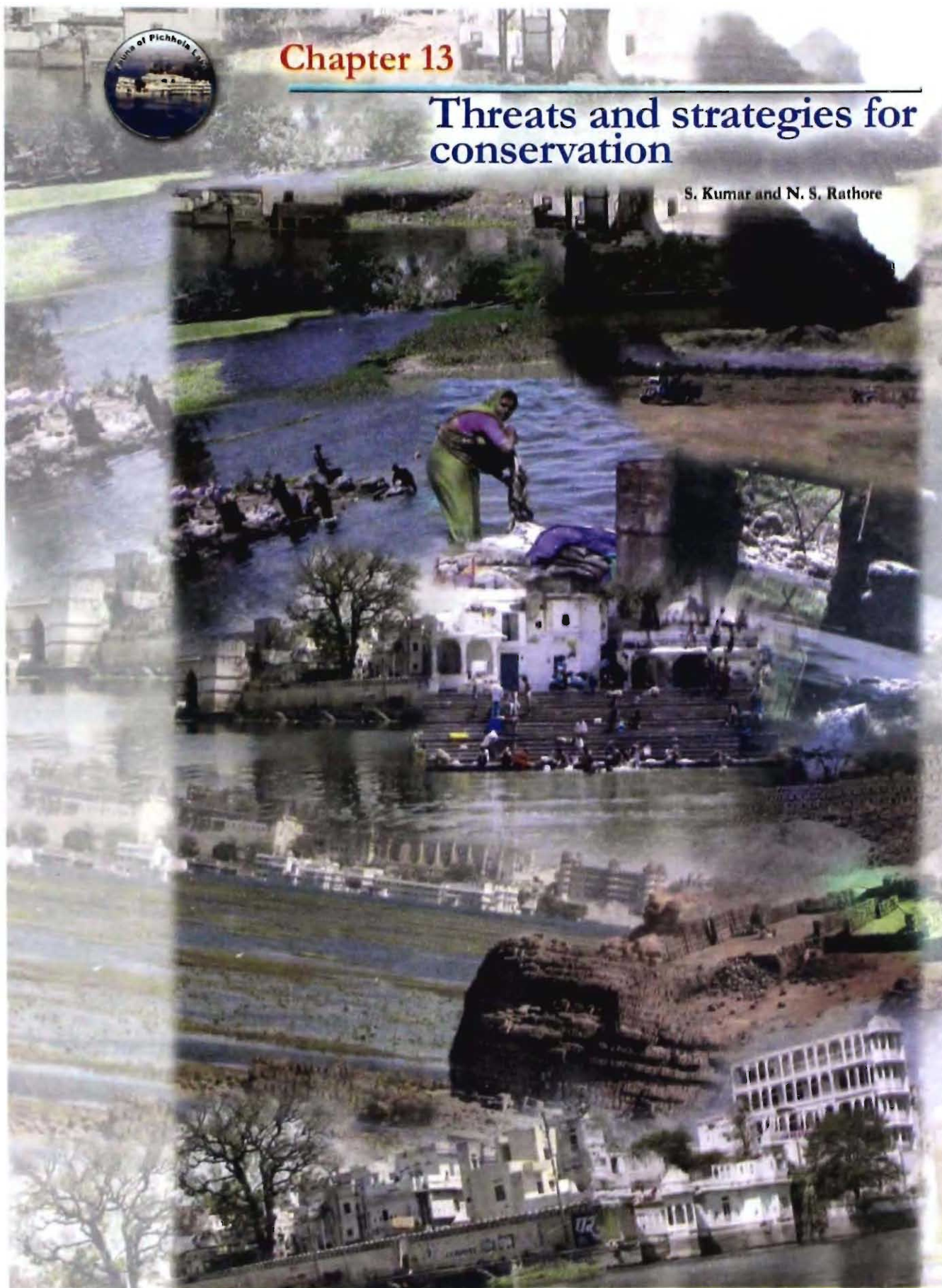
- Kumar, S. 2005. Mammals. In : *Fauna of Sambhar Lake (Rajasthan), Wetland Ecosystem Series*, 6 : 180-185. Edited and Published by the Director, Zool. Surv. India, Kolkata.
- Prakash, I. 1959. Checklist of the mammals of Rajasthan desert. *Univ. Rajasthan Stud. (Biol. Sci.)* Jaipur, (B) 6 : 30-56.
- Prakash, I. 1974. The ecology of vertebrates of the Indian desert. In: *Ecology and Biogeography in India*. M.S. Mani (ed.) Dr. Junk Verlog, The Hague : 96-121.
- Prakash, I. 1975. The ecology and zoogeography of mammals. In: *Environmental; Analysis of the Thar Desert*. (eds.), R.K. Gupta, and I. Prakash : 448-467.
- Prakash, I. 1995. Invasion of peninsula small mammals towards the Aravali ranges and the Thar Desert. *Intt. J. Ecol. & envtal. Sci.*, 21 : 17-24.
- Roberts, T.J. 1977. *The mammals of Pakistan*. Earnest benn Ltd. London and Tonbridge.
- Sharma, S.K. 1995. Mammals of Rajasthan. *Vijnana Parishad Anusandhan Patrika*, 38(4) : 267-288.
- Sharma, S.K. 1999. Mammalian fauna of Rajasthan. *Bionature*, 19(1) : 7-13.



## Chapter 13

# Threats and strategies for conservation

S. Kumar and N. S. Rathore



## **THREATS AND STRATEGIES FOR CONSERVATION**

**S. KUMAR AND N.S. RATHORE**

*Zoological Survey of India, Desert Regional Station, Jodhpur, Rajasthan*

### **INTRODUCTION**

Wetlands have attracted greater attention during past few years for their ecological, biological, and economic role in the natural ecosystem. Ecologically, wetlands have been viewed as transitional between open water and terrestrial ecosystems. They are endowed with specific structural and functional attributes performing major ecological function as a result of land water inter-action. Their biological richness of species diversity has a wider role to play in balancing the needs of a regional geographic zone.

Wetlands have several functions such as: ground water recharge, dependence of agriculture and animal husbandry, conservation of rare and endangered species (resident or migratory), pollution abatement (as waste treatment), flood control, biofertilisers and nitrogen fixation etc. Besides, wetlands have other cultural and aesthetic values. Conservation and management of natural and man-made wetlands has been advocated for various wetland values in temperate regions. But so far no effort has been made in this direction in the tropics and subtropics (Tewari, 1994).

In India the area under man-made wetlands is around 2.58 million ha. According to some estimates, only 28% of the area of 93 important wetlands in India is under total protection. This does not include large number of small and scattered wetlands throughout the country (Anonymous, 1993 a & b).

With the increase in population of the country, the pressure on wetlands is increasingly becoming unbearable to these fragile ecosystems of the land. The present state of health of these entities is deteriorating not only on account of their excessive exploitation but also largely due to neighbouring activities in the catchment area and unsustainable economic development.

Pichhola Lake is one such example of deteriorating man-made wetland facing serious threats because various such factors which in turn resulting in rapid degradation of water quality and decrease in biological diversity of the lake. Its ecosystem is now alarmingly under pressure due to both natural and man made factors such as siltation,

weed infestation, deterioration in water quality, pollution caused by kiln manufacturing units, activities of army establishment, adjoining human settlement activities and agricultural practices around the lake. Tourism and mechanized boat movement is also adding to the degradation and health of the lake (Fig. 1).

In general, Chatrath (1992) has identified main threats faced by wetlands in common as siltation, eutrophication, shrinkage of area, reclamation, encroachment, pollution, change in water quality, excessive tourism load, reduced arrival of migratory birds and over exploitation of the fisheries resource. But each wetland is facing location specific problems and threats, which are the result of geographical, social and economic developmental process.

### **PHYSIOGRAPHY OF THE LAKE**

Udaipur city is divided into two main parts viz. walled city and outskirts. Walled city is also known as old city. Outskirts include Bhupalpura, Ashok Nagar, Shakti nagar etc. which came into existence when the walled city could not contain the growth within the city. The Udaipur city has many industries such as Distilleries, Cotton Mills, Pesticides Factories, Hair Oil Factories and few small scale industries. These units also contribute their effluents to the lake causing health hazards and ecological imbalances. Udaipur Railway Station, the National Highway No. 8 connecting Delhi-Ahemdabad also passes through the city. Other parts of the country are connected by road. Dabok is its Airdrome station. The near by area is rich in rock phosphates and zinc therefore several mines are being operated by various agencies.

The natural lakes were carefully maintained by the erstwhile Maharajas of Udaipur State who further developed a complex of natural and man-made lakes. These were the main source of drinking water for the inhabitants of the Udaipur. Pichhola Lake is situated in the Udaipur city.

Pichhola Lake is surrounded by variety of habitat. The eastern side of the lake houses spots of tourist importance, high raise building of the main palace including several bathing ghats for the local population. The northern side of the lake which has also a passage of lake water draining into Rangasagar and Swaroopsagar, harbours hotels, washing ghats, and garbage dumping spots for the local population living adjoining the lake shore. A small portion of the Northwestern side of the lake having a rocky margins followed by an area as wildlife reserve of an erstwhile Maharaja of Udaipur, protects the lake in this zone. The western side of the lake receives water from river Sisarma. In the northwestern area, a vast stretch of raised land of the lake is under kiln manufacturing whereas in the southwestern area, the farmers grow vegetables on the raised margins of the lake. During late season when water is receded, the silted portion of this end becomes ideal piece of land for short-term vegetable crops cultivation, which supports the local farmer's population of the nearby village Sisarma.

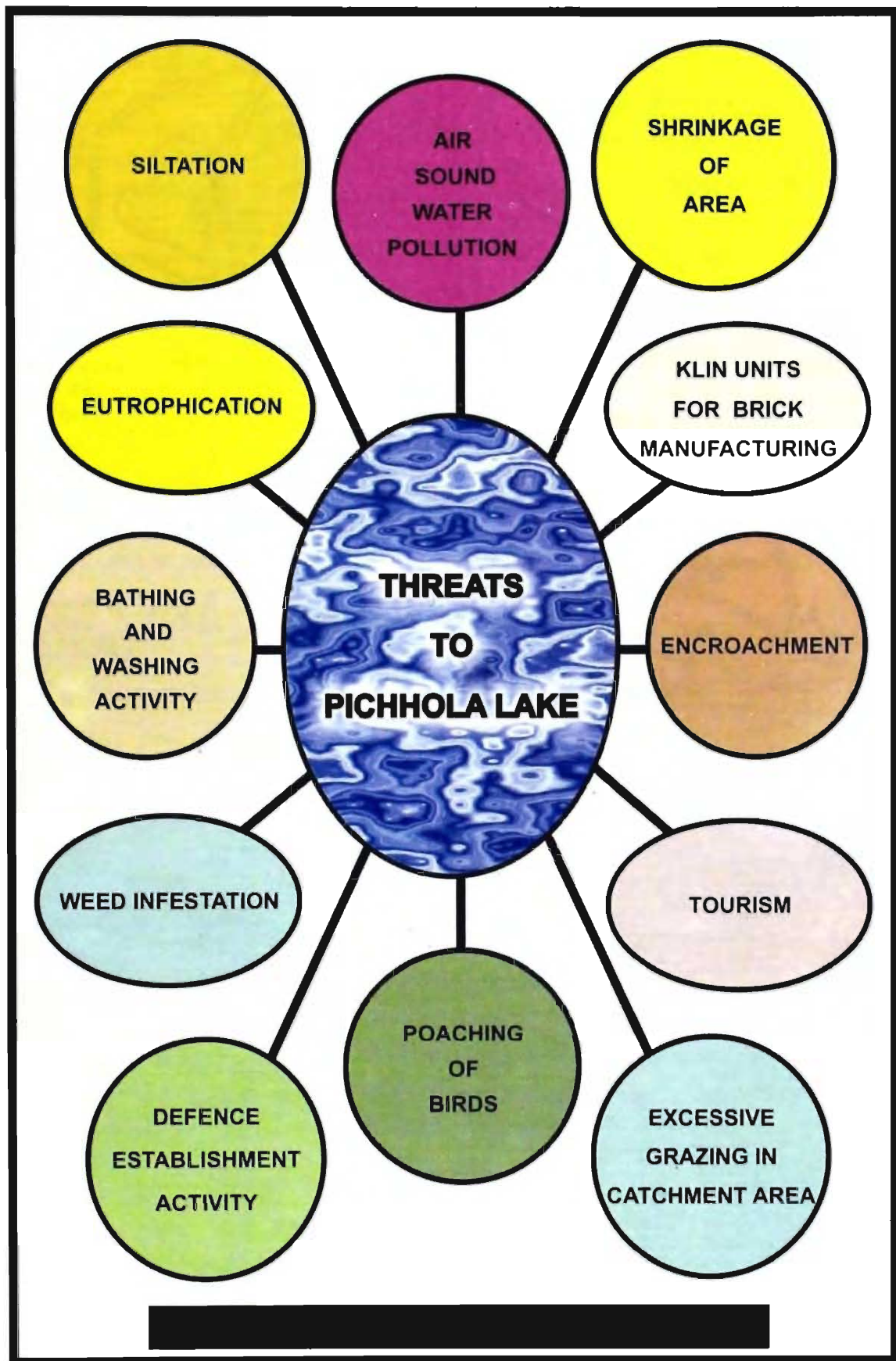


Fig. 1 : Factors degrading the health of Pichhola Lake.

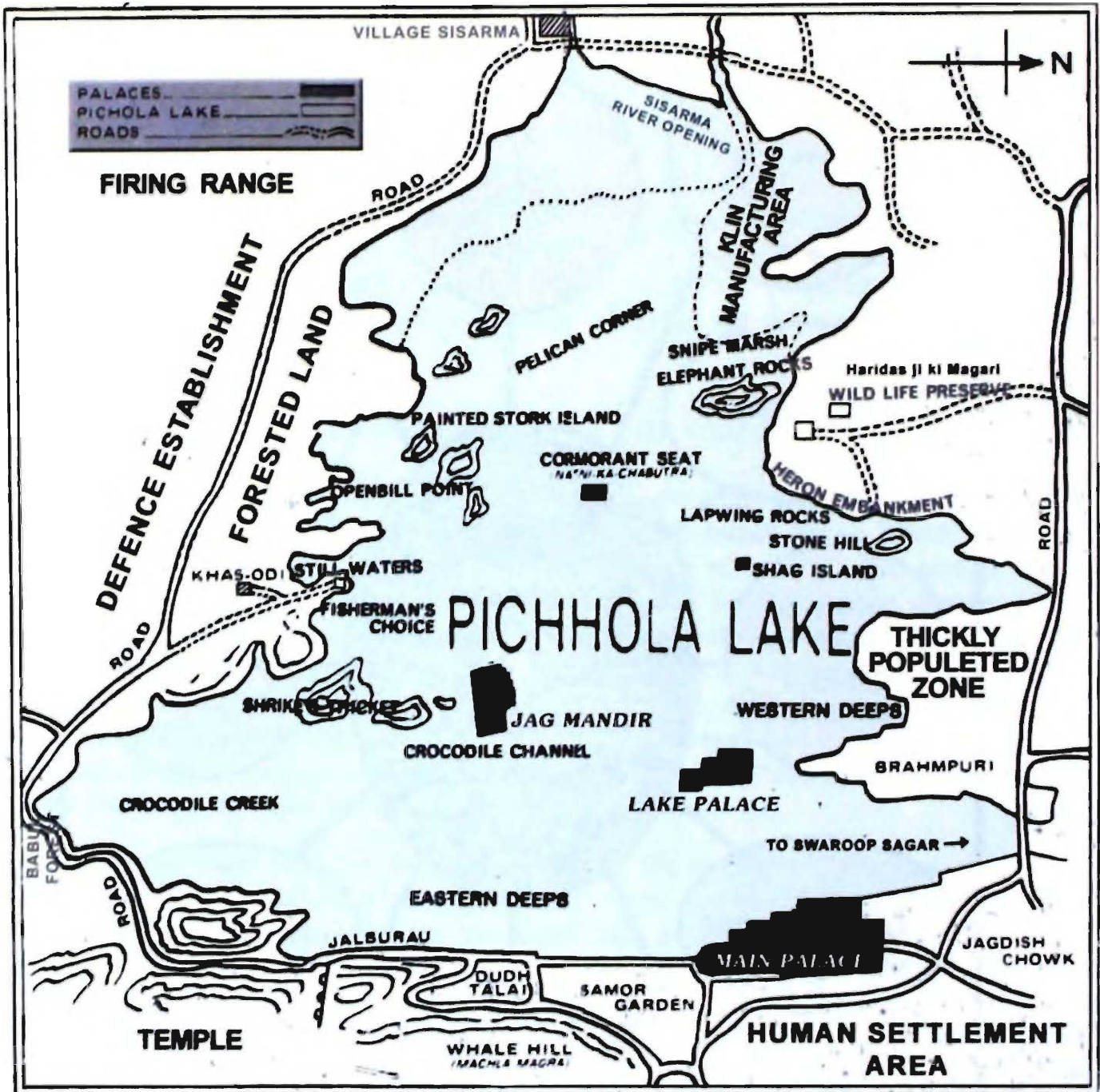
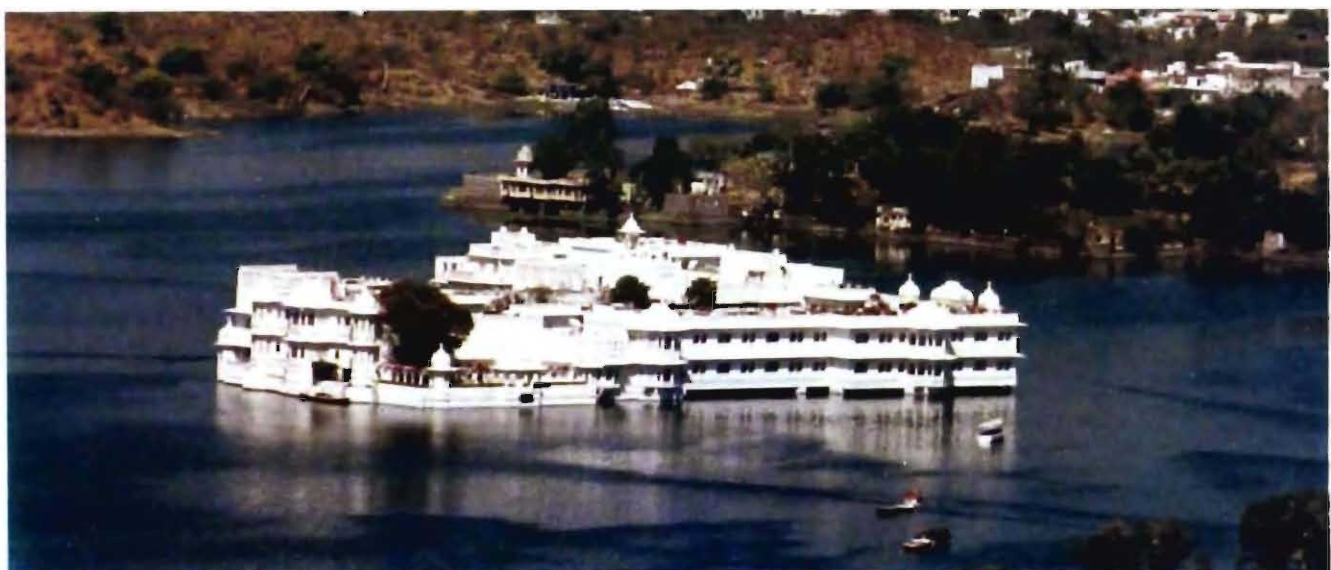


Fig. 2 : Map showing general physiography and surrounding areas of the lake Pichhola, Udaipur.  
 (Modified from : Brochure - Birds & Fishes of Pichhola Lake)

The southern side of the lake is forested followed by an area occupied by army establishment all along the length of the lake with a buffer land of about 300-400 meters in-between. From southeastern to southwestern end, the lake margins are protected except that, there was earlier wastewater drainage kept open into the lake Pichhola by army establishment, which is now closed. The southeastern end of the lake is also having biotic interference in terms of large-scale cattle grazing on the sloppy exposed land margins of the lake. Large-scale washer men's activity along with garbage dumping specially from place of worship nearby adds to the pollution of the lake. The highly degraded margins of the lake are the western and the northwestern shore region.

Within the lake waters, there are three major buildings one is a five star hotel called Lake Palace, the other one is a historical palace called Jag Mandir Palace and the third one is Natni-Ka-Chabutra-a Helipad (Fig. 2 & Photo 1). The lake has a water spread of 10.8 sq kms with a maximum depth of 9.15 m. and the average depth is 5.6 m. The present depth of the lake has reduced to 4.7 m approximately and lake has become much shallower along with decrease in water spread area due to less water supplies through a seasonal river Sisarma which is being tapped by damming in the catchment area by the farmers for irrigation purposes. The lake is the main source of drinking water for Udaipur city.



**Photo 1** : Major buildings in lake Pichhola

## FACTORS CAUSING DEGRADATION OF AQUATIC ECOSYSTEM OF LAKE PICHHOLA

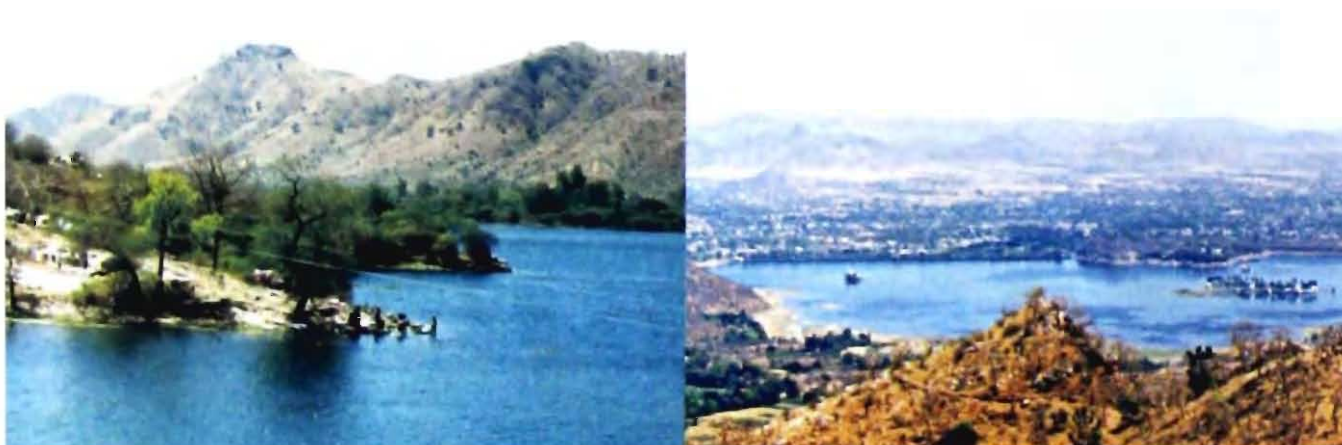
Some of the main threats faced by Pichhola Lake are as given below :

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>● Siltation</li> <li>● Shrinkage of Area</li> <li>● Encroachment</li> <li>● Defence Establishment</li> <li>● Excessive Grazing in Catchment Area</li> <li>● Weed Infestation</li> </ul> | <ul style="list-style-type: none"> <li>● Air, Sound and Water Pollution</li> <li>● Kiln for Bricks Manufacturing</li> <li>● Tourism</li> <li>● Poaching of Birds</li> <li>● Eutrophication</li> <li>● Bathing and Washing Activities</li> </ul> |
|--|---|

### SILTATION

Siltation is perhaps the most common problem faced by every wetland. The water and wind eroded particles are the chief source for sediments. Therefore, gross erosion is the potential source of siltation. In the process of siltation, the velocity of river carrying sediment is lowered substantially on entering the lakes, many of them are still water reservoirs. This causes unloading of the silt, which is analogous to delta formation.

Sediment inflow to the Pichhola Lake originates from the drainage area of River Sisarma and is transported into the lake through the river channels. The sediment yield is dependent on the soil erosion and transportation characteristic of the area. The inflow of silt increases during the rainy season. The increased human activity in the catchment area also has its impact. With deforestation, the topsoil becomes loose and with rain it finds its way into the lake Pichhola. Some of this silt gets washed out when the lake overflows. However, this inflow and outflow does not match and silt starts settling down at the bottom of the lake.



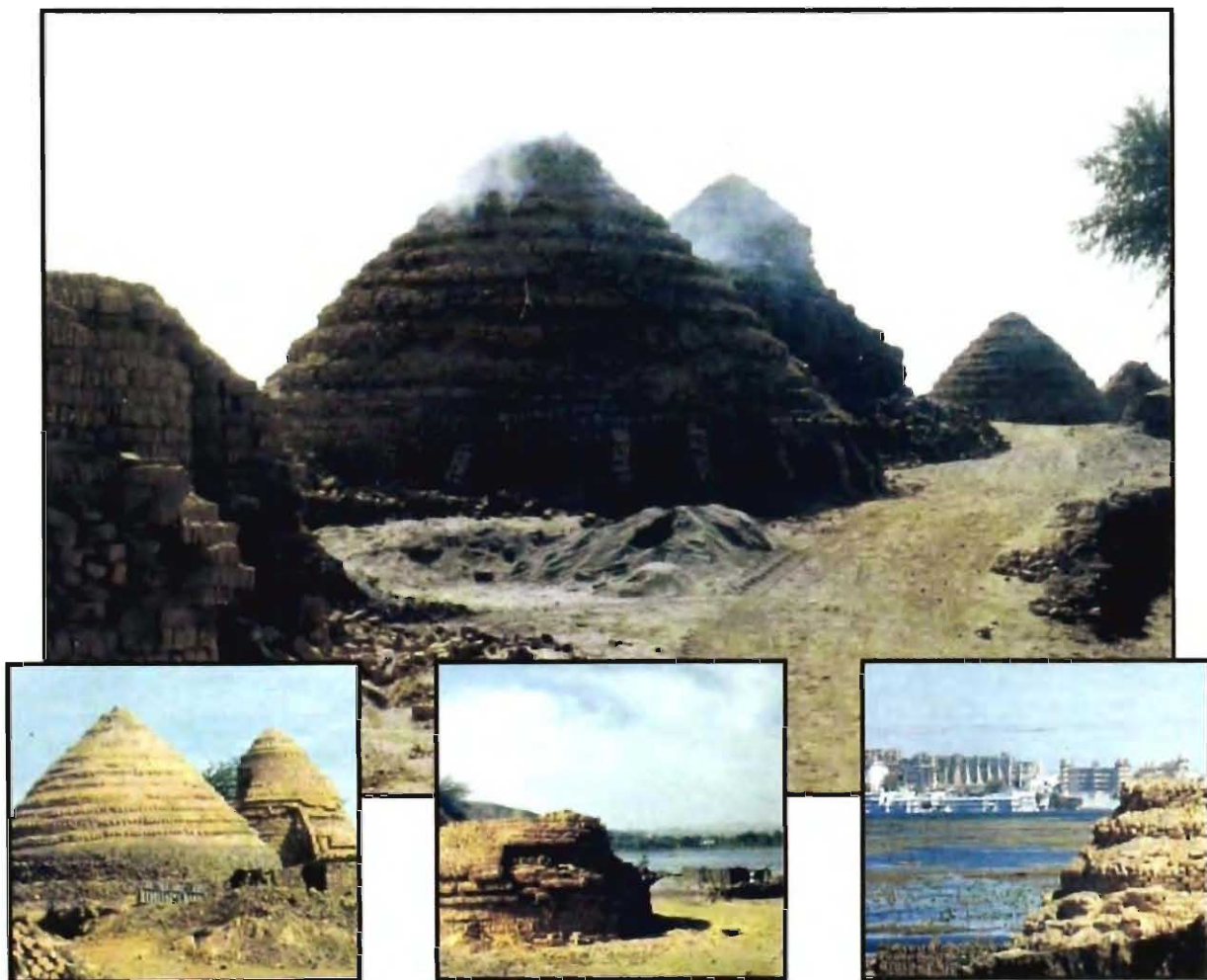
**Photo 2 : Catchment area without forest cover.**

Pichhola Lake is gradually silting and the major contributor of the silt is the river Sisarma that carries topsoil from slopes of Aravalli's along with silt waste of marble industry. Extensive deforestation of the catchment area for industrial and commercial purposes and by local people for fuel, fodder and small timber have over the years, laid bare the surrounding hill slopes of Aravalli's resulting in rampant soil erosion. Excessive, unregulated grazing around the lake has led to a serious depletion of ground vegetal cover. At present the Pichhola catchment area, is largely without forest cover (Photo 2).

The negative impact of this massive inflow of silt is manifesting themselves into two ways: firstly, the silt is getting deposited in the bed of the lake rendering it less shallow and secondly, it is resulting in the gradual decrease of the water-spread area of the lake.

### AIR, SOUND AND WATER POLLUTION

Since the old city of Udaipur was located much below the lakes, chances of pollution in these lakes was not there. But with the development of the city around the eastern slope and in areas in between the lakes and around the lakeshores resulted in the



**Photo 3** : Air pollution due to smoke of Klin manufacturing units.



**Photo 4 : Noise Pollution due to Transportation Activity.**

increase in pollution. Now with the increase in development and no attention being paid to the existing sewerage system, the pollution in lake has taken a serious form. Pichhola Lake is facing Air, Sound and Water pollution. The thick cloud of smoke from the kiln-manufacturing units is resulting into air pollution around the lake (Photo 3). Frequent movement of loading trucks also creates pollution by emitting smoke from their exhaust. The sound pollution is yet another problem. The Defence establishment near the Pichhola Lake is the main cause of sound pollution. The regular firing practice produces loud thundering sound, which disturbs the avifauna of the lake and displaces them frequently from one place to another within the lake and to other smaller wetlands near by. The trucks and tractor trolley also creates lot of noise, which disturbs the fish, as well as birds of the lake Pichhola (Photo 4). Movement of too many fishing and tourist boats also increases sound pollution.

The air and sound pollution is only a small part of the problem as compared to the water pollution in the lake Pichhola. Along with water and silt, large quantities of pesticides, fertilizers and sewage of defence establishment and ash of kiln manufacturing units are increasing water pollution (Photo 5). The oil spill from the



**Photo 5 : Water pollution due to sewage drainage and ash of Kiln manufacturing.**

tourist boats is adding to water pollution. Besides this, washing and bathing activity by the local residents daily are also adding to the pollution of the water.

Sewage disposal and wastewater drainage of hotels and the shore dwellers are also a cause of water pollution (Photo 6). Large amount of religious ceremonial waste is disposed including ashes, flowers and other waste materials. As these lakes form a major drinking water source for the people of udaipur city and especially those staying around the lake, number of water borne diseases such as Typhoid, Dysentery, infective colitis, Gastroenteritis, Diarrhoea are prevalent in the city Mehta (1997). Sewage and chemicals brought into the lake from various sources are also leading to large-scale destruction of aquatic faunal elements like invertebrates (insects etc.) and vertebrates (fishes, amphibians, reptiles, birds etc). Mass mortality of fish fry, fingerlings and other animals has been recorded. The three main polluted areas of Pichhola Lake are :

i) *Nav Ghat to Chandpole Area*

The sewerage water from the human settlement around the eastern slope of the lake from Jagdish mandir to Ganesh Ghati pours directly into lake. The residential "Havelis" and houses being used as hotels and guest houses in this area and increased human population has lead to the increase in sewage and dirt. The existing sewerage system is unable to meet out this increased sewage disposal properly and hence polluted water is being drained directly into the lake.

ii) *Brahmpuri, Naga Nagri, Panch Dewra and Brahmpole Area.*

This thickly populated area is surrounded on three sides by Pichhola Lake. The slope of western and southern part of this area is towards the lake and hence all the dirty wastes flow directly into the lake. A large number of hotels and continuous increase in population is further adding sewage into the lake. The houses in the Vaid Chagan Lal ki Badi area, outside Brahmpol are also pouring their sewage directly into the lake.

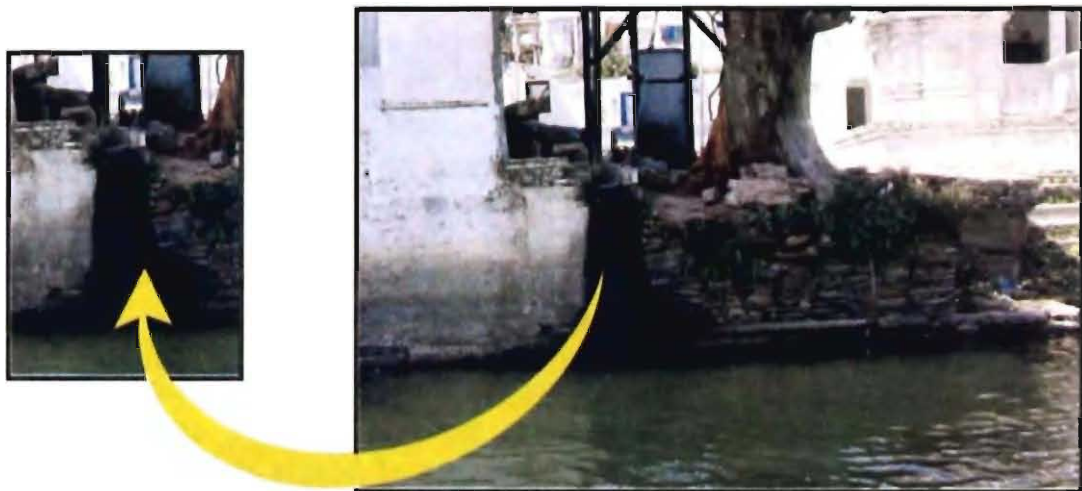
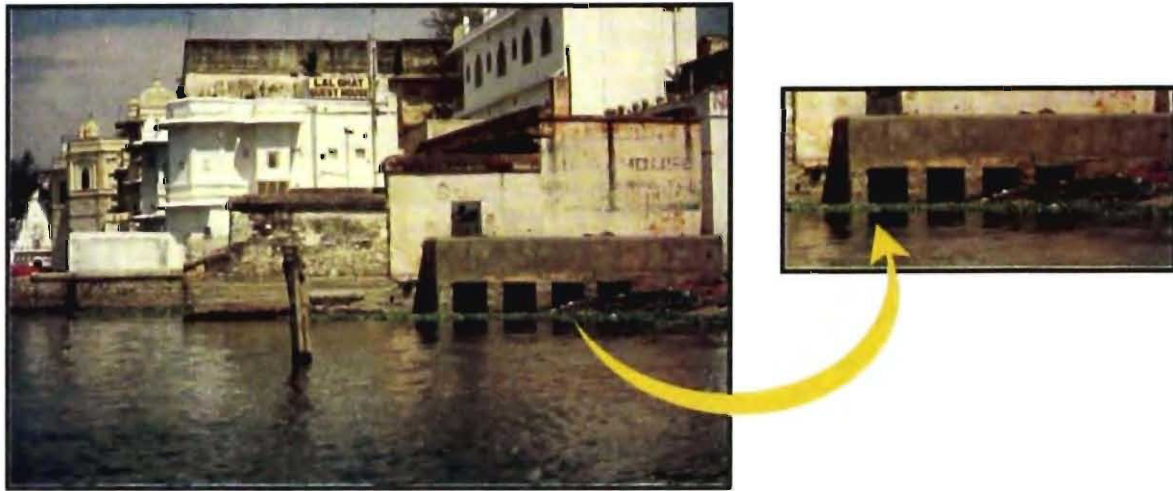
iii) *Nava Ghat to Hatipole Area*

It is being also polluted exclusively by the main sewerage line system of the city.

For disposal of city sewerage various suggestions have been made by Mehta (1996 & 1997). Existing sewerage system in the water logged area around Pichhola needs further improvement. Sewerage after treatment can be utilized for farming.

## SHRINKAGE OF THE AREA

Shrinkage of the lake area is attributed to reasons like siltation, reduced inflow of water into the lake and insufficient rains over the periods. The siltation is reducing the volume capacity of the lake to hold less water, certain areas have high deposition of silt and hence get exposed very soon when lake receives less water through river Sisarma or drainage of catchment area due to insufficient rains. The south and south-western

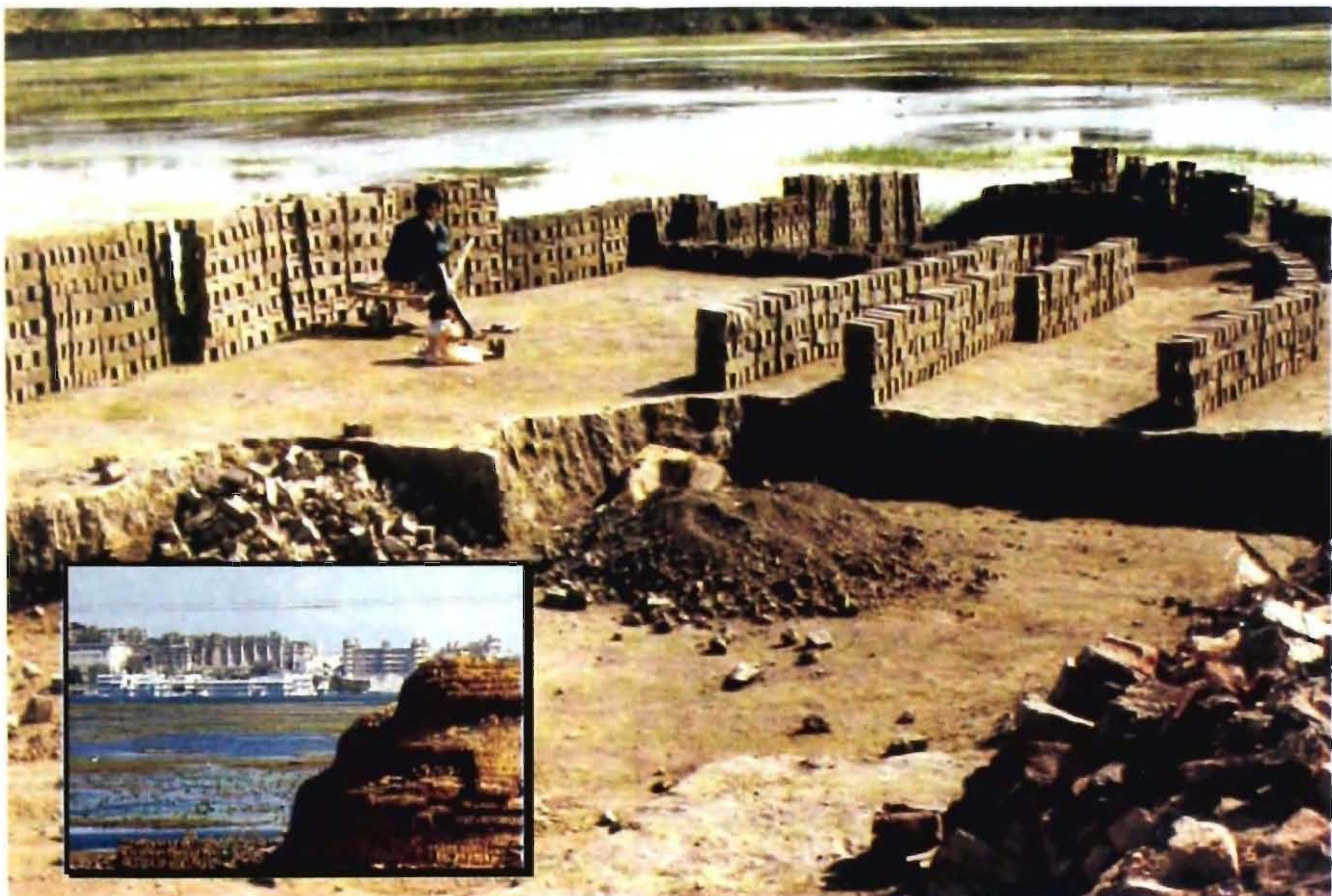


**Photo 6** : Water pollution due to human activity.

margins when remains exposed are encroached upon by farmers for agricultural purposes. The water spread area has shrunk due to various other reasons the exact data of which is lacking and needs to be studied and recorded for future area management.

### **KILN FOR MANUFACTURING BRICKS**

The kiln-manufacturing units in the northwestern side of the Pichhola Lake are the major factor of pollution for the lake biota. In a vast land, area of approximately 2 sq. kms is under soil removal and about 35-40 kiln manufacturing units are manufacturing bricks in that area (Photo 7). As a result uneven trenches are dug in a vast area near the mouth of the river Sisarma opening into the Pichhola Lake. When lake receives water during monsoon season, and reaches to its maximum capacity, these land margins become muddle pools. The uneven shallow land margins of the lake can otherwise be of great utility to wader birds but due to its fractured bed slope no bird feeds in that area except that sometimes ducks gets congregated while swimming. The kiln-manufacturing units also houses baking mounds for baking the bricks and they are as high as 15 to 20 feet in height. These units emit thick cloud of smoke for long period during baking process.



**Photo 7 : Encroachment by Kiln manufacturing units.**

The smoke when drifts with air towards the lake and spread all over, the animals especially birds get disturbed resulting in their displacement from one place to another in search of better shelter. Many bird species even locally migrate to other near by waterbodies and forested lands. Approximately 300-500 labourers work in these kiln manufacturing units and disturbs the fauna by various ways, even poach birds for food. Local business persons have encroached upon the whole area under these kiln units. Earlier to this activity the area was part of the Pichhola Lake and had a well-developed forested margin of the lake. The loading trucks and tractor trolley carrying soil for brick making works every day and their frequent movement also create pollution by emitting smoke of their exhaust and huge sound while passing through the region. These factors together amount to a complete imbalance in the ecosystem of habitat thereby resulting into degradation and absence of biotic elements from the region.

### **ENCROACHMENT**

With the increase of human habitation around the lake and its vicinity, the pressure to bring more and more land under cultivation has mounted. Shallow areas of the lake are being utilized for raising seasonal vegetables. And an income of Rs. 5000-6000 per bigha is being generated. The size of the lake is reducing as a result of these practices and also its health deteriorating day by day.

As the season advances and the water is drawn from Pichhola Lake for civil supplies, the water recedes fast and the elevated margins of the lake gets exposed specially those areas from where soil have been removed earlier leaving behind small water pools where, submerged vegetation and locked biota starts dying. The vast plateau exists at the mouth of the Sisarma River opening into the Lake and as soon as the land becomes little dried, the local inhabitants of village starts ploughing the area for vegetable cultivation. Some 50 people own the 50-bigha lands inside Pichhola Lake, which is an elevated bed of the lake. Vegetable crops of tomato, cucumber, brinjal, bitter gourd, torai, tinda, pumpkin, lady'sfinger, beans and even maize are grown in that area. Generally, farmers sow the fields as late as last week of February and harvest all the vegetables by middle of June. These vegetable crops are very much prone to insect infestation especially due to higher moisture content both in the air and in soil, these crops get easily infested with pest and to get quick relief and benefit, these farmers apply and spray lot of insecticides. The application of the insecticides leads to both atmospheric and water pollution. The birds and other animals, which take shelter in these areas, are infected with insecticides and lead to mortality and disability of animals. Even the residue left in the soil drains into the lake water when next rains brings water through Sisarma river and carries with it all the insecticides left in the soil to the waters of the lake, thereby affecting the animal and plant life.

## TOURISM

Wetlands are center of tourist attraction mainly because of boating, angling of fish and of course a place to watch avian fauna. The vast expanse of Pichhola Lake provides golden opportunity to a tourist not only to do boating or angling of fish but to have more spectacular view of waterfowls. The Lake Palace hotel, the Jag Mandir Palace and the spacious helipad building inside the waters of Pichhola Lake adds to the beauty and glory of this historic water reservoir.



Photo 8 : New hotels coming up adjoining Pichhola Lake

Pichhola is on the international map of tourism and large number of foreign and domestic tourist visits this lake almost round the year except during rainy season. Uncontrolled and insensitive tourist traffic to this lake has led to deterioration of its health by various ways. The frequent to and fro plying of boats both for maintaining a five star hotel, the lake Palace and taking the tourist for a trip in the lake are one among the most hazardous activity in polluting the lake waters through oil spillage. Further to add in these are the left over garbage like polyethylene bags, tins, glass bottles and waste food material, enough to pollute and deteriorate the lake waters. Since the magnitude of the tourist visiting this lake is very high, the amount of polluting material left is also proportionately very huge.

Another problem connected to tourism is the requirement of hotel and lodges. Large number of small hotel and lodges has come up bordering with Pichhola Lake to provide a tourist more picturesque view of the lake (Photo 8), but in doing so they have not only encroached upon the area adjoining lake but have also opened their wastewater drainage in the Pichhola Lake. All these are deteriorating the lake waters and polluting the whole ecosystem in a situation when most of these activities are uncontrolled and not checked by any civic body.

### **DEFENCE ESTABLISHMENT**

About 300-400 meters away from the forested margins of the lake, along the southern shores, Indian Military has its establishment. Their wastewater was earlier drained into Pichhola Lake but with the efforts of Zoological Survey of India team it was brought to the notice of the organization and in the year 1995-96 they established their own treatment plant and stopped releasing their sewage and wastewater into the Pichhola Lake.

Sound pollution is yet another problem, this military establishment is adding to the lake Pichhola. They have a firing range in the near vicinity and their regular firing practice does not allow the avian fauna to remain in the lake for long. The repeated thundering sound of a firing disturbs the birds of this region and displaces them frequently from one place to another within the lake. Sometimes, these shifting flocks of birds migrate locally to other smaller wetlands in order to avoid constant disturbance caused by the firing exercise of the military establishment.

### **POACHING OF BIRDS**

Hunting pressure on water birds is very heavy and migratory ducks are shot in large numbers for the sale in the city. A variety of methods are used to kill and trap avifauna - slinging, netting, gun shooting, hook and line gear and by hand. No current information is available on the number of birds poached per day.

### **EXCESSIVE GRAZING**

Excessive grazing is seriously affecting the life and age of Pichhola Lake by way of siltation. It is, therefore, important to have regulatory mechanism for grazing not only in the catchments area but also on the marginal forested land belt all around the lake. This will help solve the problem of soil erosion as also develop more luxuriant forest buffer for avian and large vertebrate population in the region. Excessive unregulated grazing around the lake has led to a serious depletion of vegetation cover and at present the Pichhola lake catchment area is largely without forest cover.

### **EUTROPHICATION**

The aging process or "eutrophication" is one of the major problems faced by many lake ecosystems. This is a process in which a lake becomes rich in nutrients by two ways: natural trophic upgradation due to assimilation process and human induced eutrophication. In both the cases nutrient enrichment of water results in the stimulation of an array of symptomatic changes, among which increased production of algae and macrophytes, deterioration of water quality and other similar changes are found to be undesirable and interfere with water uses.

The natural process of eutrophication is limited as compared to human induced one in which addition of phosphorus and nitrogen leads to increased biological activity resulting in to utter deterioration of water quality and ultimately the bio-chemical requirement of oxygen out strips the capacity of physical exchange systems to replenish the water with oxygen from air. Even low oxygen availability in the benthic zone leads to the release of nutrients from the sediments into the water column above. These additional nutrients dissolved in water result in drastic changes in the biological composition of the lake. So far no actual assessment of the problem of eutrophication has been estimated for Pichhola Lake. In order to understand the problem of human induced eutrophication, it is necessary to determine the source of nutrients input into the lake. The supply of nutrients to Pichhola Lake is from various sources. The run-off from catchment area and domestic sewage disposal from neighbouring thick habitation are some of the reasons behind eutrophication of the lake Pichhola. The rainwater drainage from agriculture fields in the catchment area is one major source of nutrients addition to the lake as most of the agriculture is agrochemical and pesticide based. Moreover, indiscriminate uses of these adversely affect the area because most of these chemicals find its way with rainwater rather than get utilized for crop cultivation. Besides, large amount of chemical and pesticides directly find their way into the lake due to cultivation within the lake Pichhola, the details of which are mentioned under encroachment.

The other sources are addition of large amount of detergents through washer men's activity as well as large number of people taking soap bath in the lake every day. Dumping of all kinds of garbage including night soil is another source of pollutants being added regularly to the lake. Till the year 1995-96, even Defence establishment was draining their wastewater into the lake Pichhola. The drainage of hotels around the lake even the household wastewater drainage of the people living around it is enormous.

There is no exact data so far collected on source, quantum and degree at which this eutrophication process is accelerated at a fast pace. But it is certain that if all parameters of significance like morphometric features, hypolimnetic oxygen deficit, high conductivity values, effluents and the drainage pattern when taken into consideration will yield a definite impact on the characteristics and the degree of eutrophication of the lake. Since quality and quantity of aquatic flora and fauna are good tools for assessing the trophic status of a water body, regular monitoring of water quality and biodiversity is required so as to save the lake ecosystem from deterioration.

### WEED INFESTATION

The growth of weeds in particular water hyacinth (*Eichhorina crassipes* Solms) is one of the greatest problems faced by Pichhola Lake. It is fast devouring the vast expanse of the lake surface and has proliferated in many of the water zones within the lake Pichhola (Photo 9). By virtue of its leaf blade and bladder like petiole adaptation it sails and floats easily within the lake area and gets congregated in certain pockets when surface wind movement displace them from one place to another. Today this plant has



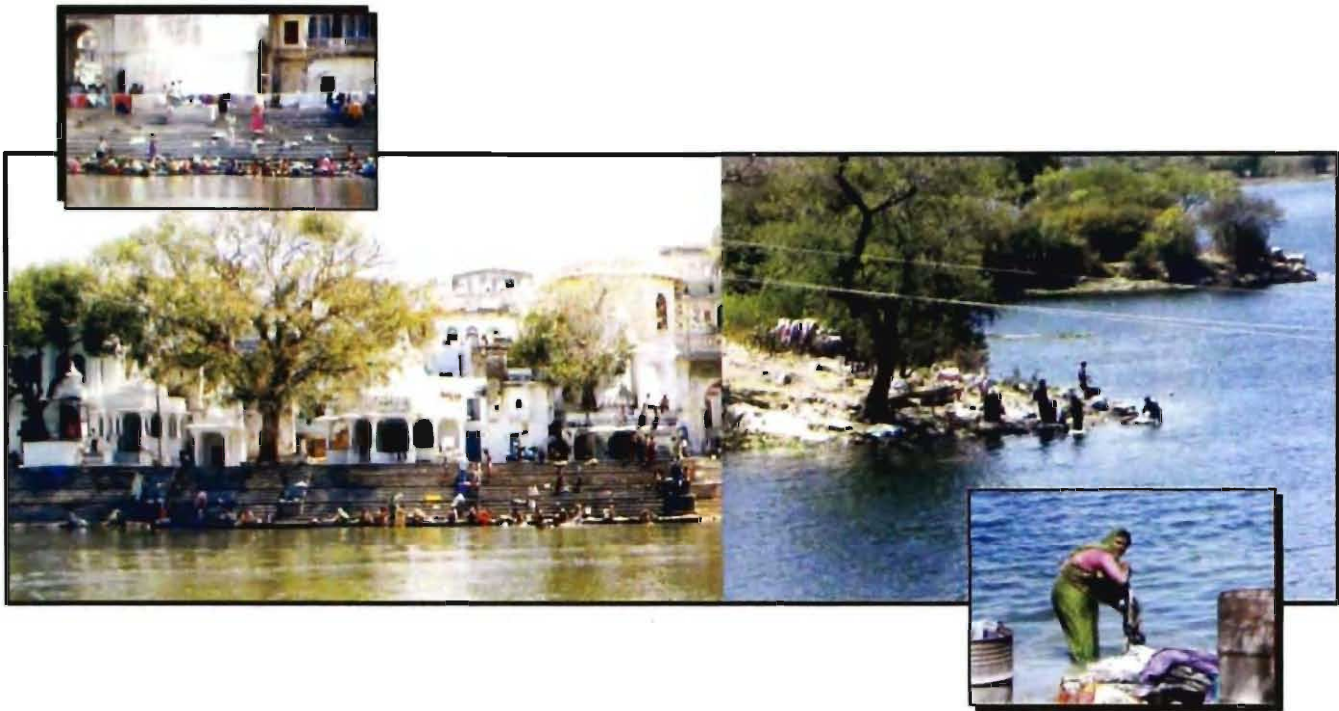
**Photo 9 : Water Hyacinth cover on lake water**

become a potential threat in blocking the penetration of light and impeding the normal rate of flow of water from one lake to another specially during heavy rains. Although this weed is known to act as a water purifier as it absorbs nutrients and heavy metals, its death and decay within the wetland can lead to re-entry of these chemicals into water leading to eutrophication. Hence, periodic removal of water hyacinth is very much required.

### **BATHING AND WASHING ACTIVITIES**

Pichhola lake being nearest to the human habitation, it is most extensively used for both bathing and washing activities by population living in adjoining areas. Large number of washer men's have their permanent washing centers throughout the lake area especially one in the southeastern side of the lake near the spot called babul woods. The other major center of washer men's activity is the area adjoining Brahmपुरi around western deeps to stone hill point. Apart from this, house hold women visit the lake daily on the ghats situated all along the eastern margin of the lake. Large quantities of detergents is poured everyday by way of washing clothes and taking a soap bath in the Pichhola Lake waters. This is resulting in increase in nitrate concentration in water accelerating not only the process of eutrophication or providing optimal opportunity for weeds to grow like water-hyacinth but also grossly unbalancing the water quality and thereby polluting the lake.

The area of these activities are also abundant or not visited by avian fauna even turtles and crocodiles do not come to these areas due to micro-habitat aversion and off-course being effected because of asphyxiation or poison inhalation. Many of these activity areas are highly polluted for which no data is available to quantify the extent of damage caused by them.



**Photo 10** : Bathing and washing activity by human settlement around the Lake

### **SUGGESTIONS FOR CONSERVATION STRATEGIES**

From the foregoing account of threats to this lake it becomes explicitly clear that the lake is passing through a stage of far and many hydro-biological changes due to men's tinkering with environmental factors which may likely to deteriorate and damage the natural balancing of metabolic digestibility of an strategically important manmade wetland ecosystem. It is, therefore, necessary to look into all the factors independently and also collectively to evolve a acceptable strategy whereby both nature and man can sustainably live together and contribute advantages to remain viable for years and centuries to come.

For the purpose of proper management of Lake Ecosystem many attempts were made. First and the foremost in this direction was the master plan of Udaipur city followed by a project on "Ecology and Conservation of Lakes in and around Udaipur, Rajasthan (Vyas, 1986) and then came the proposal in 1993 "Clean Lakes" a pilot project initiated to clean lakes of Udaipur city (Anonymous, 1993a & 1993b and 1996); Environmental Conservation and Improvement of Udaipur Lake System (Anonymous, 1997); Plan for Domestic Sewerage System of city (Collection, treatment and disposal) by Zheel Sanrakshan Samiti, Udaipur Mehta (1996 & 1997) and On Lake Management, Mehta and Razdan (2000). Under these proposals a very systematic and elaborate planning was made for civic amenities like sewerage system, city water drainage, sulabh sauchalaya etc. to be developed around these lakes in order to save it from pollution.

Many voluntary exercises were also made to remove the water hyacinth from these lakes in particular but all these attempts were only of the initiative nature and did not continue for long and hence, could do nothing in achieving the objectives. It is in the wake of this situation that some management strategies of immediate attention are briefly mentioned as under.

First and the foremost requirement is to have exact mapping of the lake and its surrounding areas through remote sensing technique and to have systematic data based on socio-economic aspects of the people dependent on the lake. If such a computerized database is developed it will be easier to interpret each individual element of dependence in a wetland of this nature.

Factors like siltation and excessive grazing have to be tackled in a wider prospective of developing the catchment's area in terms of afforestation and legal monitoring of grazing activity by the state forest department. The Pichhola Lake should be given a suitable status under Wild Life Protection Act in order to enforce legal protection to the lake environment from activities like encroachment, unchecked excessive tourism, poaching of birds, bathing and washing activities, air, sound and water pollution and all other neighbouring activities affecting the hydrobiological life of the lake.

The problem of weed infestation is directly connected to the process of eutrophication. One of the major weed infestation problem faced by Pichhola Lake is that of water hyacinth. Attempts of manual removal or use of chemicals (through water



**Photo 11 : Solar panel boat – A step towards pollution control**

threshers and air-borne herbicide sprays) are labour intensive and very expensive to afford. Even biological combat with grass carps and host-specific agents such as insects, other arthropods and fungi could not bring satisfactory results. It is the understanding of usage of weeds to derive benefit out of it. It may look to be a blessing in disguise to have water hyacinth being exploited for benefits like production of biogas, as fire wood, fertilizer and its fiber being used for pulp and paper, wood boards and plastic moulds and as a great substitute for jute. Feeding hyacinths to domestic animals is a traditional practice in countries like China, Malaysia, Indonesia and Philippines. It is also used as fodder for ducks, broilers, swine, horses, cattle, sheep and goats. If proper awareness is built up for various uses of water hyacinth probably it may no longer remain a weed at all rather cultivation of it may be advocated in future time to come. This will also help solve the problem of eutrophication of the lake as it absorbs several toxic residues such as nitrates, phosphates, sulphates, chromium, lead, mercury, arsenate, nickel and certain phenolic compounds and act as a natural siphon or vacuum to clean water.

During the course of these investigative surveys the Zoological Survey of India team, could mobilise the opinion of many agencies to work in controlling pollution-creating activities. The defence establishment organization stopped draining their wastewater into Pichhola Lake and set-up their own treatment plant. The erstwhile H.L.H. Maharana Shriji Arvind Singhji Mewar, Udaipur, also launched a boat totally driven by energy of solar cells and had the plan to change all the boats with solar panels in a phased manner. Various NGO bodies also approached the businesspersons of the kiln-manufacturing units and probably most of them have withdrawn their units from the area. These are some of the paramount measures taken during the course of our study period in reducing the potential threats to the lake Pichhola. More can be done in this direction by building up awareness amongst the people directly drawing benefit from the lake as also those involved in implementation/execution of policies of the Government. Sensitization of the importance and the problems of wetlands amongst scientists, students, NGO's and any one who is connected directly or indirectly to these jewels of the civilization can save them from becoming lands of dry earth.

#### **ACKNOWLEDGEMENTS**

Authors are thankful to Scientist-F-Incharge and Dr. J.R.B. Alfred, Ex-Director, Zoological Survey of India, Kolkata and to the Officer-in-charge of Desert Regional Station, Z.S.I. Jodhpur to provide opportunity and facilities to work on this wetland of National Importance. We are also thankful to the Estate of H.L.H. Maharana Shriji Arvind Singh Mewar, Udaipur and owner of the Lake Palace hotel as well as the landowner of the Lake Pichhola to allow us to work in the lake waters. We express our gratitude to the State Forest Department, Udaipur and various other agencies in helping us to collect information on this wetland.

**REFERENCES**

- Anonymous, 1993 a. *Clean Lakes : A Pilot project, Udaipur*. (Draft Proposal) : 1-36 and Appendix A–C.
- Anonymous, 1993 b. *Environment Action Programme, India*. Ministry of Environment and Forests, Govt. of India.
- Anonymous, 1996. *Domestic sewerage system of city* (Collection, treatment and Disposal). Feasibility Report. Zheel Sanrakshan Samiti, Udaipur. Steel Authority of India Limited, Centre for Engineering and Technology, Ranchi. (CET/17/FR/1181(R-1)).
- Anonymous, 1997. *Environmental improvement of Udaipur Lake System*. Pre-Feasibility Report (Vol. I : Past and Present Status) and (Vol. II : Action Plan and Financial Layout). Committee of Experts and Zheel Sanrakshan Samiti, Udaipur.
- Chatrath, K. J. S. 1992. *Wetlands of India*. Publ. by Ashish Publ. House. New Delhi : xiv + 1-200.
- Mehta, A. 1996. *Domestic sewerage system of city* (collection, treatment and disposal). Feasibility report. Zheel Sanrakshan samiti, Udaipur, Steel Authority of India Limited, Centre for Engineering and Technology, Ranchi. (CET/17/FR/1181R-1). Unpublished Report.
- Mehta, A. 1997. *Environmental Conservation and Improvement of Udaipur Lake System in retrospect*. Action Plan. Unpublished Report.
- Mehta, A. and Razdan, T. 2000. Zonal workshop on lake management. *Jheel Sanraskshan Samiti* (JSS), Vidya Bhawan Society (VBS) and Global Water Partnership (GWP) – SASTAC Regional Centre. Unpublished Report.
- Tewari, D. N. 1994. *Forests and Environment*. International Book Distributors, Dehra Dun : 88-99.
- Vyas, L. N. 1986. *Ecology and Conservation of Lakes in and around Udaipur* (Rajasthan). Final Project MAB Project No. 20/46/81-MAB/ENV-2. Department of Botany, College of Science, Sukhadia University, Udaipur.

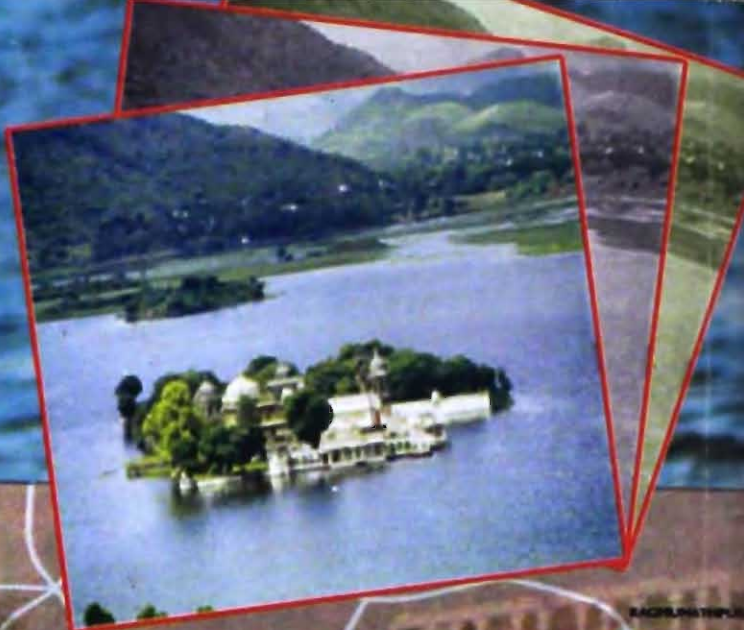


Photo: S. Jaising

Photo: S. Jaising