I. CLADOCERA OF KEOLADEO NATIONAL PARK, BHARATPUR, AND ITS ENVIRONS[1]

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(With forty-nine text-figures)

A study made on collections of zooplankton from shallow waters and ponds in and around Keoladeo National Park, Bharatpur, yielded 39 species of Cladocera, of which 25 are recorded for the first time from Rajasthan. Some selected species recorded in the present study are illustrated and described.

INTRODUCTION

Very little is known regarding the occurrence of different species of Cladocera in Rajasthan, particularly the Keoladeo National Park, which has a wide range of freshwater habitats and attracts various migratory birds from different parts of the world. The important earlier works on Cladocera of Rajasthan are those of Biswas (1964), Nayar (1971) and Venkataraman (1988, 1990). Ali and Vijayan (1983) studied the general limnology, primary productivity and secondary productivity in Keoladeo National Park. There are also some records of the protozoan species (Mahajan *et al.* 1980a), benthic fauna (Mahajan *et al.* 1980b) and dynamics of zooplankton (Mahajan *et al.* 1980c) made in freshwater habitats of the Keoladeo National Park (KNP).

The material for the present study was collected periodically from eight different places in the Park and 30 ponds and ditches of Rajasthan. The collections revealed 39 species of Cladocera, of which 25 are new records to Keoladeo National Park and Rajasthan. Short description including illustration of diagnostic features of a few interesting species is given in this paper. The impact of introduced fauna is also discussed.

MATERIAL AND METHODS

591 zooplankton samples were collected during the years 1984-85 from littoral and limnetic regions of freshwater habitats of Keoladeo National Park (27° 7.6′ to 27° 12.2′ N, 77° 29.5′ to 77° 39.9′ E) and roadside ponds and ditches in and around Bharatpur, Rajasthan. The collections were made with 80 μm mesh size plankton nets of 30 cm upper diameter by taking both vertical and horizontal hauls. All samples were examined with a binocular microscope and the species were separated. Temporary slides were made in glycerine for confirming diagnosis. Drawings were made with a camera lucida and the measurements taken using a calibrated ocular micrometer. A list of species recorded is given in Table 1.

KNP has a wide range of freshwater habitats. About 10% of the land is covered with water that comes from a reservoir during the rainy season. This reservoir receives and retains faunal elements from flowing and standing waters used for irrigation via Gambir and Banganga rivers. The climate is subtropical and temperate, with 1200 mm annual rainfall. There were 120 rainy days in the year June 1984 to May 1985. The mean annual temperature was 22°C; the lowest temperature (3°C) was recorded on 14 January and the highest (42°C) on 27 July 1984.

DESCRIPTION OF FEMALES OF SELECTED SPECIES

Pseudosida bidentata Herrick, 1884 (Figs. 1-2)

Size: 1.20 mm. Body elongated oval; head short; eye relatively small and situated near antero-ventral corner. Antennules unsegmented, long and attached to postero-ventral part of head. Antenna not extending beyond posterior margin of valves. Ventral margin with a series of long setae followed by a series of spinules on postero-ventral corner. Postabdomen short and broad. Lateral side with 10 groups of spines. Claw long, curved dorsally; convex surface serrated; concave surface with series of short setules and three basal

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TABLE 1
LIST OF CLADOCERA RECORDED FROM KEOLADEO NATIONAL PARK AND ITS ENVIRONS

Family Sididae	
*1.	*Pseudosida bidentata* Richard
*2.	*Latonopsis australis* Sars
3.	*Diaphanosoma excisum* Sars
*4.	*Diaphanosoma sarsi* Richard
*5.	*Diaphanosoma senegalensis* (Gauthier)
Family Daphnidae	
6.	*Daphnia similis* Claus
*7.	*Daphnia longispina* Muller
8.	*Daphnia lumholtzi* Sars
9.	*Simocephalus vetulus elizabethae* (King)
*10.	*Simocephalus acutirostratus* Sars
11.	*Ceriodaphnia cornuta* Sars
12.	*Ceriodaphnia reticulata* (Jurine)
13.	*Scapholeberis kingi* Sars
Family Macrothricidae	
14.	*Ilyocryptus spinifer* Herrick
15.	*Macrothrix spinosa* King
16.	*Macrothrix triserialis* (Brady)
*17.	*Grimaldina brazzai* Richard
*18.	*Guernella raphalis* Richard
Family Moinidae	
19.	*Moina micrura* Kurz
*20.	*Moinodaphnia macleayii* Richard
Family Bosminidae	
*21.	*Bosminopsis deitersi* Richard
Family Chydoridae	
*22.	*Alona costata* Sars
*23.	*Alona davidi* Richard
*24.	*Alona monacantha* Sars
*25.	*Alona karua* King
26.	*Alona verrucosa* Sars
*27.	*Camptocercus australis* Sars
28.	*Chydorus eurynotus* Sars
*29.	*Chydorus parvus* Daday
*30.	*Chydorus ventricosus* Daday
*31.	*Dadaya macrops* (Daday)
*32.	*Dunhevedia crassa* King
*33.	*Euryalona orientalis* (Daday)
*34.	*Kurzia longirostris* (Daday)
*35.	*Leydigia australis* Sars
36.	*Leydigia acanthocercoides* (Fischer)
*37.	*Indialona ganapati* Petkovski
*38.	*Oxyurella sinhalensis* (Daday)
*39.	*Pluroxus similis* Vavra

* New records

spines. Occurs in all types of habitat except in turbid ponds.

Latonopsis australis Sars, 1888 (Figs. 3-4)

Size: 1.15 mm. Body oblong. Head short and indistinctly separated from the body. Eye small, situated near antero-dorsal end of head. Ocellus small and situated near base of labrum. Antennules long and segmented, attached to antero-ventral corner of head. Valves slightly convex dorsally and broadly rounded ventrally. Ventral margin with a series of long setae. Postabdomen short without anal denticles, lateral surface with a series of 8-10 denticles. Claw curved dorsally with two long basal spines. Occurs in all types of habitat except in turbid ponds.

Diaphanosoma excisum Sars, 1885 (Figs. 5-6)

Size: 1.05 mm. Head large and rounded anteriorly. Eye small. Postero-ventral corner broadly rounded with 5-9 marginal denticles followed by a series of fine setules. Claw serrated on the distal convex surface; concave surface with three long basal spines.

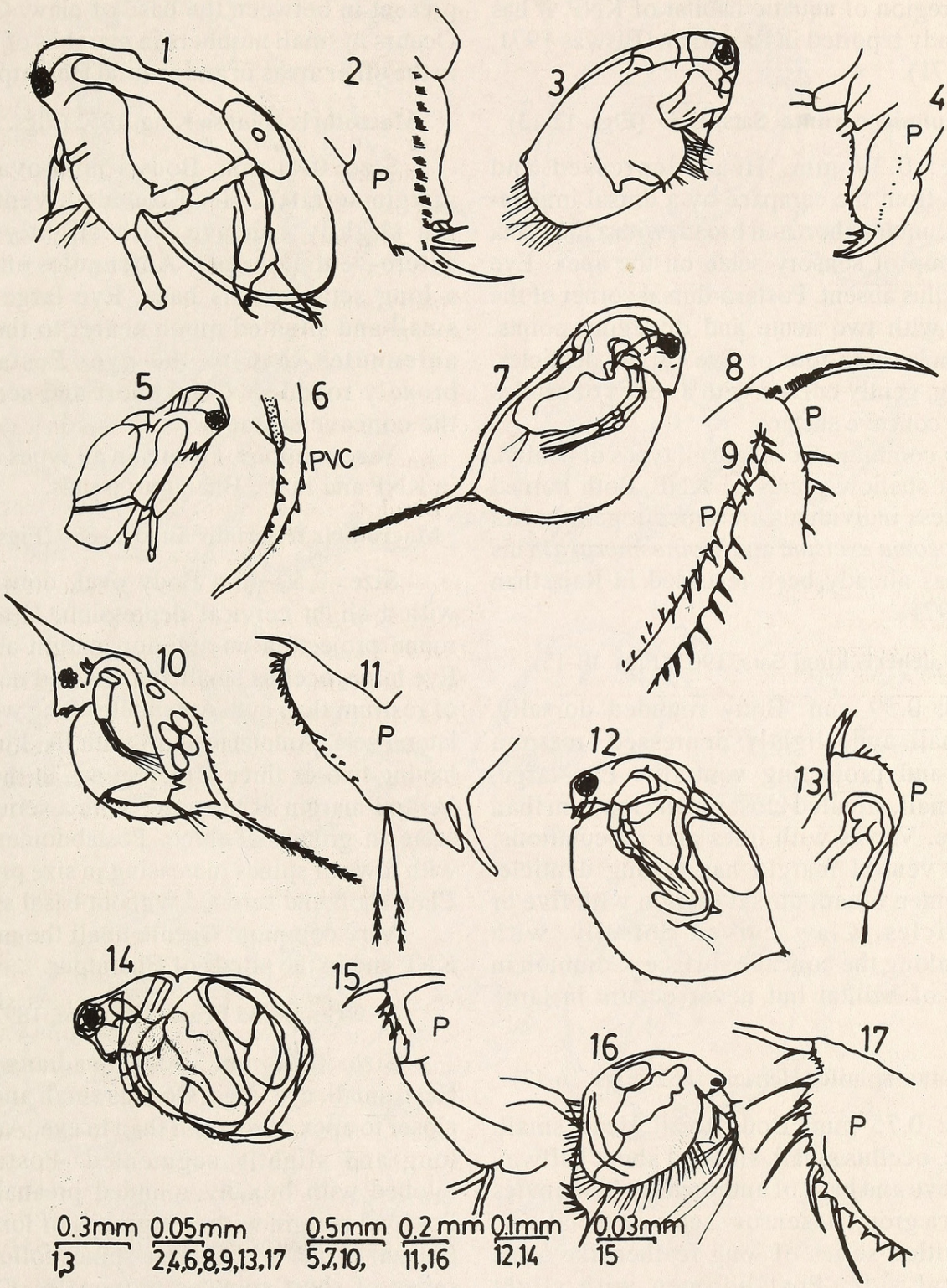
Very common. Occurs in all types of habitat except in marshes. This species has already been recorded in Rajasthan (Biswas 1971, Nayar 1971).

Daphnia similis Claus, 1876 (Figs. 7-9).

Size: 2.25 mm. Body slightly compressed, elliptical in shape. Head rounded anteriorly, rostrum pointed ventrally; antennules short, attached to posterior margin of rostrum. Eye large, situated slightly closer to the antero-ventral margin of the head. Valves with a series of spinules on dorsal and ventral margins. Postabdomen narrow distally with about nine pointed denticles. Rare. Occurs only in turbid ponds of Bharatpur.

Daphnia lumholtzi Sars, 1885 (Figs. 10-11)

Size: 1.52 mm. Head with pointed helmet. Rostrum small, fornix well developed. Body rounded. Dorsal and ventral margins with a series of spines. Postabdomen long and narrow with 9-11 denticles on the dorsal side.



Figs. 1–17. Cladocera of Keoladeo National Park and environs (females). P– postabdomen; PVC– postero-ventral corner. 1-2. *Pseudosida bidentata*; 3-4. *Latonopsis australis*; 5-6. *Diaphanosoma excisum*; 7-9. *Daphnia similis*; 10-11. *D. lumholtzi*; 12-13. *Ceriodaphnia cornuta*; 14-15. *Scapholeberis kingi*; 16-17. *Ilyocryptus spinifer.*

This is the commonest *Daphnia* sp. in the limnetic region of aquatic habitat of KNP. It has been already reported in Rajasthan (Biswas 1971, Nayar 1971).

Ceriodaphnia cornuta Sars, 1885 (Figs. 12-13)

Size: 0.39 mm. Head depressed and separated from the carapace by a dorsal impression. Antennules short and broad, with a long seta and a group of sensory setae on the apex. Eye large, ocellus absent. Postero-dorsal corner of the carapace with two acute and diverging points. Postabdomen with four or five curved denticles. Claw long, gently curved with a series of setules along the concave surface.

Very common. Occurs in all types of habitat, especially shallow ponds of KNP. Both horned and hornless individuals are found together with *Diaphanosoma excisum* and *Moina micrura*. This species has already been recorded in Rajasthan (Nayar 1971).

Scapholeberis kingi Sars, 1903 (Figs. 14-15)

Size: 0.59 mm. Body rounded dorsally. Head small and slightly depressed, rostrum rounded and projecting ventrally. Eye large, ocellus small, situated closer to the rostrum than to the eye. Valves with lines and reticulations; posterior ventral margin has a long denticle. Postabdomen broad, dorsal margin with five or six denticles. Claw curved dorsally, with spinules along the concave surface. Common in all types of habitat but never occurs in large numbers.

Ilyocryptus spinifer Herrick, 1882 (Figs. 16-17)

Size: 0.75 mm. Body oval. Head small. Eye large, ocellus small, situated about halfway between eye and base of antennules. Antennules long with a group of sensory setae on distal end. Valves with a series of long feather-like setae on ventral side. Postabdomen with slight depression in the middle. Preanal margin with eight marginal denticles, postanal margin with 12 denticles up to anal groove and with five long and stout spines on the lateral surface. Claw with two basal spines. Three spinules present in between the base of claw. Common. Occurs in small numbers in marshes of KNP and in the other areas in and around Bharatpur.

Macrothrix spinosa King, 1852 (Figs. 18-19)

Size: 0.41 mm. Body round-oval; dorsal margin serrated. Head rounded, ventral margin slightly concave with slightly pointed antero-ventral corner. Antennules short, with a long seta near its base. Eye large, ocellus small and situated much nearer to the base of antennules than to the eye. Postabdomen broadly rounded. Claw short and serrated on the concave surface.

Very common. Occurs in all types of habitat in KNP and in the Bharatpur ponds.

Macrothrix triserialis Brady, 1886 (Figs. 20-21).

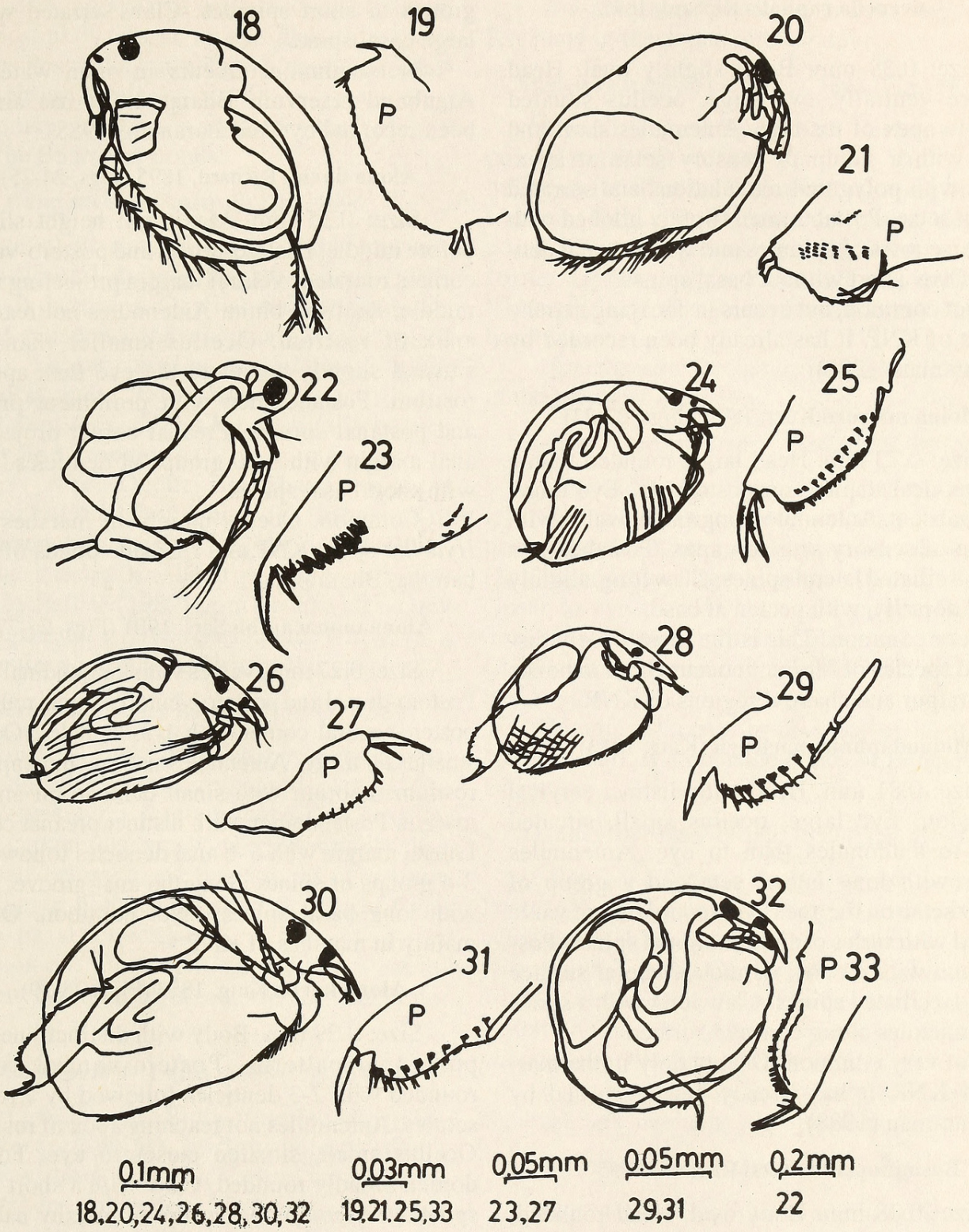
Size: 0.56 mm. Body oval, dorsal margin with a slight cervical depression. Head with a round projection on anterior margin above eye. Eye large, ocellus small and situated nearer apex of rostrum than eye. Antennules long with a long lateral seta. Antennae short with the longest seta having two or three larger spines in the middle. Ventral margin of the valve with a series of long setae in groups of three. Postabdomen bilobed with rows of spines increasing in size proximally. Claw short and serrated without basal spine.

Very common. Occurs in all the marshes of KNP and in the ponds of Bharatpur.

Grimaldina brazzai Richard, 1892

Size: 0.87 mm. Body quadrangular-oval. Head small, eye large. Ocellus small and situated closer to apex of rostrum than to eye. Antennules long and slightly segmented. Postabdomen bilobed with broadly rounded preanal margin. Postanal margin with two groups of long spines. Preanal corner with 2 large spines followed by a series of short spinules proximally. Claw long with basal spines.

Rare. Only a few specimens occurred in marshes of KNP. It has already been recorded by Venkataraman (1990).



Figs. 18-33. Cladocera of Keoladeo National Park and its environs, (females). P – postabdomen.
18-19. *Macrothrix spinosa*; 20-21. *M. triserialis*; 22-23. *Moina micrura*; 24-25. *Alona davidi*; 26-27. *A. monacantha*; 28-29. *A. karua*; 30-31. *A. verrucosa*. 32-33. *Chydorus eurynotus*.

Guernella raphalis Richard, 1892

Size: 0.38 mm. Body slightly oval. Head concave ventrally, eye large, ocellus situated closer to apex of rostrum. Antennules short and broad with a group of sensory setae at apex. Valves with polygonal reticulations and serrated without setae. Postabdomen slightly bilobed with transverse rows of spinules and without anal denticles. Claw short without basal spines.

Not common, but occurs in decaying marshy regions of KNP. It has already been recorded by Venktaraman (1990).

Moina micrura Kurz, 1874 (Figs. 22-23)

Size: 0.73 mm. Head large, rounded with a deep cervical depression posteriorly. Eye large, ocellus absent. Antennules long and movable with a group of sensory setae on apex. Postabdomen with 6-8 ciliated lateral spines. Claw long, slightly curved dorsally, with pecten at base.

Very common. This is the most widely distributed species of *Moina*. It occurs both in ponds of Bharatpur and shallow regions of KNP.

Moinodaphnia macleayii (King, 1853)

Size: 0.81 mm. Head with distinct cervical depression. Eye large, ocellus small, situated closer to antennules than to eye. Antennules slender with long lateral seta and a group of sensory setae on the apex. Ventral margin of valve rounded with series of short marginal spines. Postabdomen without anal denticles, lateral surface with 8-10 ciliated spines. Claw long with a series of short setules along concave surface.

Not very common. Occurs only in the marshes of KNP. It has already been recorded by Venkataraman (1988).

Bosminopsis deitersi Richard, 1895

Size: 0.38 mm. Body oval. Head rounded, rostrum long with two lateral branches. Eye large. Valves with polygonal reticulations, dorsal margin with cervical depression, ventral margin with a long and pointed marginal spine on the postero-ventral corner. Postabdomen small with 4-6 groups of short spinules. Claw serrated with a large basal spine.

Not common. Occurs in open waters of Ajanbund reservoir, Bharatpur. It has already been recorded by Venkataraman (1988).

Alona davidi Richard, 1895 (Figs. 24-25)

Size: 0.35 mm. Maximum height slightly before middle. Postero-dorsal and postero-ventral corners rounded. Ventral margin projecting in the middle. Rostrum blunt. Antennules not reaching apex of rostrum. Ocellus smaller than eye, situated slightly nearer to the eye than apex of rostrum. Postabdomen with prominent preanal and postanal corners. Preanal corner projecting, anal margin with 8-10 groups of denticles. Claw with short basal spines.

Common. Occurs mainly in marshes with *Hydrilla* sp. in KNP and roadside ponds of Banbaretha, Bharatpur.

Alona monacantha Sars, 1901 (Figs. 26-27)

Size: 0.27 mm. Valves with longitudinal lines. Postero-dorsal and postero-ventral corners rounded, postero-ventral corner with 1-3 denticles. Ocellus smaller than eye. Antennules not reaching apex of rostrum. Labrum with small denticle on anterior margin. Postabdomen with distinct preanal corner. Lateral margin with 6 -8 anal denticles followed by 3-4 groups of spines along the anal groove. Claw with long basal spines. Not common. Occurs mainly in marshes of KNP.

Alona karua King, 1853 (Figs. 28-29).

Size: 0.29 mm. Body with distinct lines and polygonal patterns. Postero-ventral corner rounded with 2-3 denticles followed by a row of setules. Antennules not reaching apex of rostrum. Ocellus small, situated closer to eye. Postabdomen broadly rounded. Claw with a short basal spine. Very common. Occurs in marshy habitats of KNP.

Alona verrucosa Sars, 1901 (Figs. 30-31).

Size: 0.28 mm. Body oval. Postero-ventral and postero-dorsal corners rounded. Antennules

almost reaching apex of rostrum. Ocellus small, situated slightly closer to eye than to apex of rostrum. Postabdomen with 5-6 denticles. Claw with short basal spine.

Common. Occurs in all marshy areas of KNP and in the Bharatpur ponds.

Camptocercus australis Sars, 1896

Size: 0.82 mm. Head smoothly curved. Postero-ventral margin slightly convex with 3-4 small denticles. Ocellus smaller than eye, situated closer to the eye than to the tip of rostrum. Labrum wedge-shaped and slightly rounded at apex. Postabdomen long with 16-18 anal denticles. Claws long, slightly curved dorsally and pointed.

Very rare. Occurs in Ghana canal of Keoladeo National Park. This is the first record of its occurrence in the Oriental region. However, the same species has been reported as a new species by Battish (1989) from Renuka lake. Only the comparison of type-specimens will give a clear picture about the validity of this species.

Chydorus eurynotus Sars, 1901 (Figs. 32-33)

Size: 0.24 mm. Body shape slightly oval. Postero-dorsal and postero-ventral corners distinct. Valves with faint reticulation. Rostrum slightly curved posteriorly. Ocellus smaller than eye, situated closer to eye than to apex of rostrum. Postabdomen with 10-12 short denticles. Claw with two basal denticles.

Common. Occurs in all marshy areas of Keoladeo National Park and in the Bharatpur ponds.

Chydorus parvus Daday, 1898 (Figs. 34-35)

Size: 0.28 mm. Body rounded. Postero-dorsal corner distinct, postero-ventral corner rounded without denticle. Ventral margin with 2-3 chitinous tubercles. Surface of carapace without reticulation. Ocellus smaller than eye and situated closer to eye than to tip of rostrum. Postabdomen with distinct preanal corner. Dorsal margin with 6-8 anal denticles. Claw with two basal spines.

Not common. Occurs in marshy regions of KNP and in the ponds of Bharatpur.

Chydorus ventricosus Daday, 1898 (Figs. 36-37).

Size: 0.76 mm. Body oval. Postero-ventral corner rounded, without denticle. Valves with hexagonal markings. Rostrum long and pointed. Labrum long, curved anteriorly and slightly pointed. Postabdomen long with distinct preanal corner. Dorsal margin with 9-10 anal denticles. Claw setulated along concave surface with two basal spines.

Not common. Occurs in marshes of KNP and in the ponds of Bharatpur.

Dadaya macrops (Daday, 1898) (Figs. 38-39).

Size: 0.48 mm. Body oval with polygonal reticulations. Postero-ventral corner with a distinct denticle. Rostrum short, antennules long. Ocellus and eye large, ocellus situated slightly closer to eye than to apex of rostrum. Postabdomen with 10 groups of irregular sized denticles. Claw with setules on concave surface and a long basal spine.

Common. Occurs in marshes of Keoladeo National Park and roadside ponds of Banbaretha, Bharatpur.

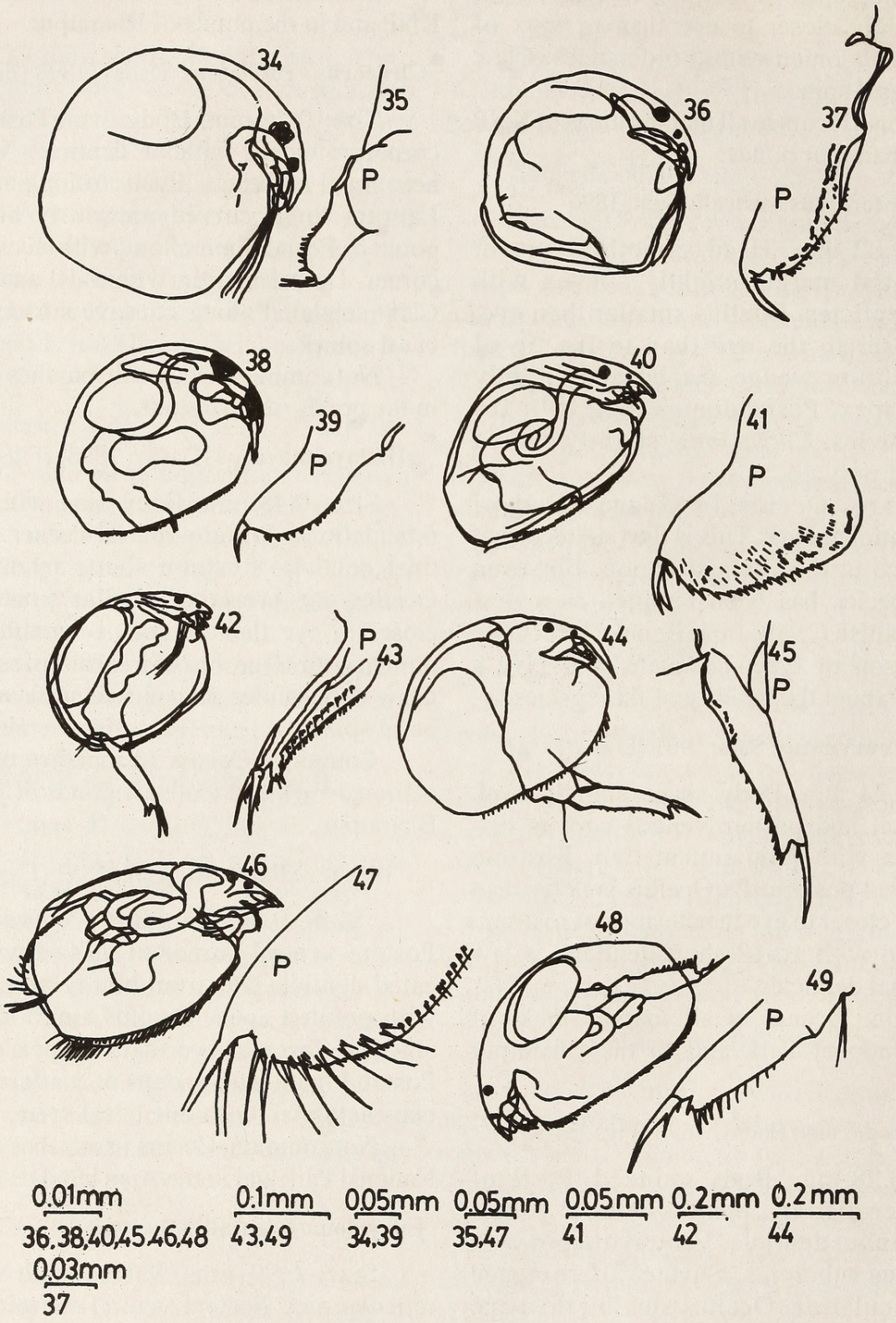
Dunhevedia crassa King, 1853 (Figs. 40-41)

Size: 0.53 mm. Body curved dorsally. Postero-ventral corner of valves with a bifurcated denticle. Rostrum blunt, labrum rounded with pointed apex. Ocellus small and situated slightly closer to eye than to apex of rostrum. Postabdomen with groups of scattered spinules, claw setulated with one basal spine.

Not common. Occurs in marshes of Keoladeo National Park and in the Ajan bund reservoir.

Euryalona orientalis (Daday, 1898). (Figs. 42-43)

Size: 0.99 mm. Valves with rectangular reticulations. Postero-ventral margin of valves with series of setae. Rostrum blunt, antennules almost reaching apex of rostrum. Labrum rounded with a nipple-like structure on apex. Postabdomen long with 20 pointed denticles decreas-



Figs. 34-49. Cladocera of Keoladeo National Park and its environs (females). P–postabdomen.
34-35. *Chydorus parvus*; 36-37. *Chydorus ventricosus*; 38-39. *Dadaya macrops*; 40-41. *Dunhevedia crassa*; 42-43. *Euryalona orientalis*; 44-45. *Kurzia longirostris*; 46-47. *Leydigia acanthocercoides*, 48-49. *Oxyurella sinhalensis*.

ing in size proximally. Claw long with a very short basal spine. Common among weeds in KNP.

Kurzia longirostris (Daday, 1898) (Figs. 44-45)

Size: 0.45 mm. Valves without longitudinal lines. Rostrum long, antennules short, reaching half of the rostrum. Ocellus smaller than eye, situated nearer to the eye than to the apex of rostrum. Labrum with slightly pointed apex. Postabdomen long with 12 groups of denticles present dorsally; lateral side with 11-12 groups of short setules. Claw long with a short basal spine. Rare. Occurs among the weeds in KNP.

Leydigia acanthocercoides (Fischer, 1854) (Figs. 46-47)

Size: 0.89 mm. Valves with longitudinal lines. Rostrum blunt, antennules not reaching apex of rostrum. Ocellus smaller than eye, situated closer to the eye than to the apex of rostrum. Labrum rounded with fine setae. Postabdomen with about 18 groups of small denticles, each group consists of 3 or 4 denticles with the distal-most denticle being the longest of each group. Claw with a short basal spine.

Rare, occurs in reddish-brown algal covered ponds of Bharatpur.

Indialona globulosa (Daday, 1898)

Size: 0.36 mm. Valves with striations. Rostrum short and blunt, antennules not reaching the apex. Ocellus smaller than the eye, situated closer to the eye than to the apex of rostrum. Labrum serrated on antero-ventral margin. Postabdomen long with 12 or 13 anal denticles, claw long with 12 or 13 anal denticles, claw long with short basal spine.

Rare. Occurs in small numbers in marshes of KNP and Banbaretha ponds.

Oxyurella sinhalensis (Daday, 1898) (Figs. 48-49)

Size: 0.82 mm. Valves evenly rounded. Rostrum blunt, antennules not reaching the apex. Ocellus smaller than the eye and situated closer to the eye than to the apex of rostrum. Labrum round. Postabdomen long with 10-12 anal denticles which decrease in size proximally. Claw long with a long basal spine and three short spines proximal to the basal spine. Not common. Occurs in the marshes of KNP.

Discussion

The cladoceran fauna of Keoladeo National Park has some features unique to this region. A total of 39 species of Cladocera belonging to six families is recorded in the present study, of which 25 are recorded for the first time from Rajasthan. An analysis of the published records shows that in a tropical region around 60 species have been normally recorded, while a temperate region supported around 95 species of Cladocera (Fernando 1980). The six species of limnetic Cladocera are limited in this region compared to temperate regions. As an example, in Ontario at Canada, Brandlova *et al.* (1972) recorded 18 species of limnetic Cladocera.

Similar figures can be quoted for all the northern temperate regions (Flossner 1972, Manuilova 1964, Scourfield and Harding 1966). In the southern temperate zone, Hebert (1977) found 10 limnetic species of *Daphnia* in south-eastern Australia. On the other hand, the number of species in Sri Lanka (Fernando 1980), south India (Venkataraman 1983) as well as other tropical areas of south-east Asia (Fernando 1980) is less than that of temperate regions. However, in Keoladeo National Park lying within the temperate zone, only three species of *Daphnia*, namely *D. similis, D. lumholtzi* and *D. longispina*, occurred.

Venkataraman (1983) recorded and commented upon six species of non-Indian cladoceran species in south India. Ghetti (1970) also recorded one non-European ostracod species in Italy. More recently Fernando (1980) recorded two unexpected species from Sri Lanka. Mukhamediev (1951) considered seed (agricultural) as a means of transporting tropical fauna and flora into subtropical regions of the USSR.

There is thus enough evidence to show the presence of temperate Cladocera in tropical India (Venkataraman 1983) and Sri Lanka (Fernando

1980). The present study also reveals the cladoceran species *Daphnia similis, Diaphanosoma senegalensis, Camptocercus australis, Leydigia australis* and *Pluroxus similis* as introduced ones. Birds have been considered an important agency for the dissemination of microcrustaceans in freshwaters (Thienemann 1950, Loffler 1963, Smirnov 1974). Keoladeo National Park attracts several aquatic bird migrants (Ali and Vijayan 1983). Perhaps bird sanctuaries, besides attracting aquatic migratory birds, also provide congenial conditions for the alien fauna and flora to colonise these aquatic ecosystems.

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