



Faunal diversity of Cladocera (Crustacea: Branchiopoda) of Nokrek Biosphere Reserve, Meghalaya, northeastern India

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Abstract: Thirty-four species of Cladocera, belonging to 24 genera and seven families, documented from the Nokrek Biosphere Reserve of Meghalaya indicate fairly speciose and diverse taxocoenosis and comprise 57.7% of species known from this state. *Coronatella anodonta* is the first confirmed report from India and two species are new records from Meghalaya. *Disperalona caudata* is an interesting Australasian element and a number of species show regional distributional importance. The Cladocera of the Nokrek Biosphere Reserve show tropical characteristics with Cosmopolitan > Cosmotropical species, and are characterized by a distinct richness of the littoral-periphytonic members of the Chydoridae as well as a paucity of limnetic elements. The species richness of Cladocera in various localities ranges between 11–24 (15±3) species.

Keywords: Alpha diversity, conservation area, India, micro-crustaceans.

INTRODUCTION

The systematic studies on Indian freshwater Cladocera were initiated by Baird (1860) but there is yet limited information on faunal and ecosystem diversity of these entomostracous crustaceans from different states of India in general (Sharma & Michael 1987; Michael & Sharma 1988; Sharma 1991) and in aquatic ecosystems of its conservation areas in particular. The studies on occurrence and distribution of these fish-food organisms in aquatic biotopes of conservation areas of northeastern India are limited to the reports from two Ramsar sites (Sharma & Sharma 2008, 2009) and two preliminary lists from Meghalaya by Hattar et al. (2004) and Sharma (2010a). This pioneering study on Cladoceran alpha diversity of the Nokrek Biosphere Reserve, Meghalaya is interesting in view of the paucity of biodiversity studies of this area. An inventory of the documented species is presented. Comments are made on the biogeographically interesting species as well as on the richness, nature and composition of Cladoceran fauna.

MATERIALS AND METHODS

The present study is a part of our investigations on faunal diversity of zooplankton of the Nokrek Biosphere Reserve (NBR) which is spread over parts of East, West and South Garo Hills districts of the state of Meghalaya, northeastern India (Fig. 1). It was declared a national park in 1997 and was designated a biosphere reserve in May, 2009. NBR

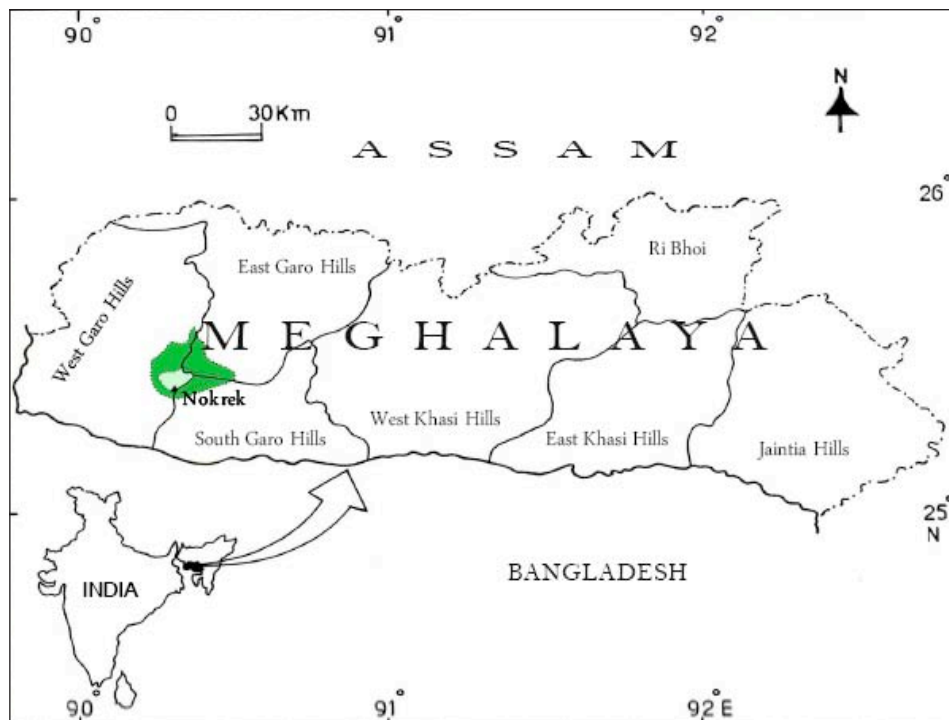


Figure 1. District map of Meghalaya showing location of Nokrek Biosphere Reserve (indicated in dark green) and its core area shown in light green; (after Sharma & Sharma 2011).

abounds in various wildlife including elephants, hoolock gibbons, rare varieties of birds and pheasants, rare orchids and is a 'National Citrus Gene Sanctuary' to a very rare endemic species of *Citrus indica* (locally called 'memang narang' or 'orange of the spirits').

One hundred and ten qualitative plankton samples were collected from 33 localities (four localities only partially sampled) of the Nokrek Biosphere Reserve (25°21'–25°34'N & 90°14'–90°29'E), during July and September 2009 and January 2010, by towing a nylobolt plankton net (# 55µm) and were preserved in 5% formalin. The sampled biotopes, in this otherwise hilly terrain, include shallow rain-fed water bodies and some perennial ponds, often with filamentous algae, semi-terrestrial vegetation and a few with *Eichhornia crassipes*. All the samples were screened with a wild-stereoscopic binocular microscope and the cladocerans were isolated. Permanent mounts of different species made in a Polyvinyl-alcohol lactophenol mixture were examined with a Leica DM 1000 image analyzer. The Cladocera were identified following Smirnov (1971, 1974, 1996), Michael & Sharma (1988), Sharma & Sharma (1999, 2008) and Van Damme et al. (2010). An account of faunal diversity of Rotifera present in our collections was published recently by Sharma & Sharma (2011).

RESULTS

The details of the sampled localities of the NBR are given in Table 1 along with the number of species collected from each locality. In addition, Table 2 includes a systematic list of the Cladocera examined in this study.

DISCUSSION

Thirty-four species of Cladocera observed in our collections from the NBR reveal the fairly speciose nature of these micro-crustaceans. Our report is important in view of a total of 58 species of this group known to date from the state of Meghalaya (vide Sharma & Sharma 1999; Sharma 2008, 2010b). The recorded richness also assumes importance in light of a conservative estimate (Fernando & Kanduru 1984; Sharma & Michael 1987; Sharma 1991) of the occurrence of up to 60–65 species of Cladocera from tropical and subtropical parts of India. *Coronatella anodonta* is the first confirmed report from India; *Disperalona caudata* and *Chydorus ventricosus* are new records from Meghalaya. Our samples are characterized by rich generic diversity: out of

Table 1. List of the sampled localities

| Dates of collection | Locality | Location | Species recorded (vide list: Table 2) |
|--|---------------------|------------------------------|--|
| East Garo Hills | | | |
| 12.vii.2009, 20.ix.2009, 02.i.2010, 27.i.2010 | Manchuri Chiring | 25°34'26.2"N 90°18'44.1"E | 1, 2, 3, 5, 8, 9, 10, 13, 15, 17, 21, 22, 24, 28, 30, 32, 34 = 17 |
| 12.vii.2009, 20.ix.2009, 02.i.2010, 27.i.2010 | Dinamangre | 25°33'32.0"N 90°19'13.8"E | 1, 2, 3, 4, 6, 8, 10, 11, 13, 16, 17, 18, 23, 24, 25, 30, 31, 32, 33 = 19 |
| 12.vii.2009, 20.ix.2009, 02.i.2010, 27.i.2010 | Dinamangre I | 25°33'37.9"N 90°19'29.1"E | 2, 4, 6, 8, 9, 10, 11, 12, 13, 17, 21, 22, 24, 27, 28, 32 = 16 |
| 12.vii.2009, 20.ix.2009, 02.i.2010, 27.i.2010 | Chirapat Chiring | 25°33'08.2"N 90°22'42.1"E | 1, 2, 3, 4, 5, 7, 8, 9, 10, 13, 14, 17, 19, 20, 21, 22, 24, 25, 26, 28, 29, 30, 32, 34 = 24 |
| 12.vii.2009, 20.ix.2009, 02.i.2010, 27.i.2010 | Chirapat | 25°33'06.9"N 90°22'41.6"E | 2, 3, 5, 8, 9, 10, 13, 17, 21, 24, 30, 33 = 12 |
| 12.vii.2009, 27.i.2010 | Chirapat I | 25°33'07.7"N 90°22'42.3"E | 2, 5, 8, 9, 10, 13, 17, 21, 24, 30, = 10 |
| 13.vii.2009, 19.ix.2009, 03.i.2010, 28.i.2010 | Mandal Chiring | 25°31'29.2"N 90°21'58.9"E | 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 16, 17, 18, 20, 23, 24, 25, 30, 31, 32, 33 = 22 |
| 13.vii.2009, 19.ix.2009, 03.i.2010, 28.i.2010 | Mandal Chiring I | 25°30'28.9"N 90°21'57.2"E | 1, 2, 4, 5, 6, 8, 9, 10, 11, 13, 17, 18, 21, 24, 25, 30, 31, 32 = 18 |
| 13.vii.2009, 19.ix.2009, 03.i.2010, 28.i.2010 | Mandalgre | 25°30'31.2"N 90°21'58.1"E | 1, 4, 7, 8, 9, 10, 13, 15, 17, 19, 21, 24, 28, 32, 34 = 15 |
| 13.vii.2009, 19.ix.2009 | Mandalgre I | 25°30'31.2"N 90°21'58.1"E | 2, 5, 8, 11, 13, 17, 19, 22, 24, 26, 32 = 11 |
| 13.vii.2009, 19.ix.2009, 03.i.2010, 28.i.2010 | Daribokgre | 25°29'27.9"N 90°19'55.5"E | 2, 4, 5, 7, 8, 9, 13, 14, 15, 17, 18, 21, 22, 24, 28, 39, 32 = 17 |
| 13.vii.2009, 19.ix.2009, 03.i.2010, 28.i.2010 | Adugre | 25°28'55.0"N 90°29'10.9"E | 1, 2, 7, 8, 9, 10, 11, 13, 17, 18, 19, 25, 30, 32, 34 = 15 |
| West Garo Hills | | | |
| 14.vii.2009, 21.ix.2009, 05.i.2010, 29.i.2010 | Kalupara Chiring | 25°34'15.2"N 90°14'04.1"E | 4, 5, 6, 8, 10, 12, 13, 17, 21, 22, 24, 25, 28, 29, 30, 32, 33 = 17 |
| 14.vii.2009, 21.ix.2009, 05.i.2010, 29.i.2010 | Manchuri Chiring | 25°33'25.8"N 90°18'44.0"E | 1, 2, 7, 8, 9, 11, 13, 17, 18, 21, 22, 24, 27, 30, 31, 32 = 16 |
| 14.vii.2009, 21.ix.2009, 05.i.2010, 29.i.2010 | Tosekgre | 25°32'54.0"N 90°17'59.0"E | 2, 5, 8, 9, 10, 12, 16, 17, 21, 25, 28, 30, 32, 34 = 14 |
| 14.vii.2009, 21.ix.2009, 05.i.2010, 29.i.2010 | Matchurigre | 25°32'53.3"N 90°17'37.9"E | 4, 5, 8, 9, 11, 13, 17, 18, 21, 22, 24, 26, 30, 32, 34 = 15 |
| 14.vii.2009, 29.i.2010 | Matchurigre I | 25°32'55.3"N 90°16'59.1"E | 2, 6, 8, 10, 13, 16, 17, 21, 25, 30, 32 = 11 |
| 15.vii.2009, 22.ix.2009, 06.i.2010, 30.i.2010 | Sasategre Chiring | 25°28'10.0"N 90°15'40.1"E | 1, 2, 3, 4, 6, 8, 9, 10, 11, 13, 15, 17, 19, 20, 21, 22, 24, 26, 30, 32, 33 = 21 |
| 15.vii.2009, 29.i.2010 | Sasategre Chiring I | 25°28'40.0"N 90°16'10.3"E | 2, 8, 10, 11, 12, 17, 22, 24, 28, 30, 32 = 11 |
| 15.vii.2009, 22.ix.2009, 06.i.2010, 30.i.2010 | Sasategre | 25°28'10.0"N 90°15'40.1"E | 2, 4, 7, 8, 11, 13, 17, 19, 21, 22, 24, 25, 29, 30, 34 = 15 |
| 15.vii.2009, 22.ix.2009, 06.i.2010, 30.i.2010 | Sangkenigiri | 25°24'13.2"N 90°14'39.0"E | 1, 2, 8, 9, 10, 11, 15, 17, 21, 22, 24, 28, 31, 32 = 14 |
| 15.vii.2009, 22.ix.2009, 06.i.2010, 30.i.2010 | Dapgre | 25°23'23.9"N 90°16'27.3"E | 3, 4, 7, 8, 9, 10, 13, 17, 21, 23, 25, 28, 32, 34 = 14 |
| 15.vii.2009, 22.ix.2009 | Dapgre I | 25°23'24.5"N 90°17'38.1"E | 2, 4, 6, 10, 11, 12, 17, 22, 24, 32 = 10 |
| 15.vii.2009, 22.ix.2009, 06.i.2010, 30.i.2010 | Rongram Chiring | 25°22'54.5"N 90°17'01.8"E | 2, 4, 5, 8, 9, 10, 13, 17, 21, 22, 25, 28, 30, 32, 34 = 15 |
| South Garo Hills | | | |
| 11.vii.2009, 23.ix.2009, 07.i.2010, 31.i.2010 | Reng Sangre | 25°24'52.1"N 90°16'09.0"E | 1, 2, 4, 7, 10, 13, 14, 16, 17, 22, 27, 28, 30, 32 = 14 |
| 11.vii.2009, 23.ix.2009, 07.i.2010, 31.i.2010 | Reng Sangre I | 25°24'12.6"N 90°16'39.2"E | 2, 5, 7, 8, 9, 11, 13, 17, 18, 21, 24, 25, 28, 30, 34 = 15 |

| Dates of collection | Locality | Location | Species recorded (vide list: Table 2) |
|--|-------------------|------------------------------|---|
| 11.vii.2009, 23.ix.2009, 07.i.2010, 31.i.2010 | Mitapgre | 25°23'50.9"N 90°16'27.3"E | 1, 2, 4, 5, 8, 9, 10, 13, 17, 21, 22, 24, 39, 32, 33 = 15 |
| 11.vii.2009, 23.ix.2009, 07.i.2010, 31.i.2010 | Mitapgre I | 25°23'57.0"N 90°16'27.8"E | 2, 5, 8, 9, 10, 12, 16, 17, 21, 25, 28, 39, 32, 34 = 14 |
| 11.vii.2009, 23.ix.2009, 07.i.2010, 31.i.2010 | Nengirang Chiring | 25°21'00.5"N 90°25'58.9"E | 1, 4, 6, 9, 10, 13, 17, 18, 23, 24, 28, 30, 32 = 13 |
| 08.i.2010 | Chokpot Bibagre * | - | 4, 8, 10, 12, 17, 24 = 6 |
| 08.i.2010 | Chokpot * | - | 5, 7, 10, 11, 19, 31 = 6 |
| 08.i.2010 | Chokpot Market * | - | 4, 9, 10, 17, 32 = 5 |
| 08.i.2010 | Gilmatkolgre* | - | 2, 6, 10, 13, 17, 30, = 6 |

*only representative collections, hence, not considered for richness comparisons

Table 2. Systematic list of the examined Cladocera

Super-class: Crustacea

Class: Branchiopoda

Super-order: Cladocera (s. str.)

Ctenopoda: Sididae

1. *Diaphanosoma excisum* Sars, 1885
2. *D. sarsi* Richard, 1895
3. *Pseudosida bidentata* Herrick, 1884

Anomopoda: Daphniidae

4. *Ceriodaphnia cornuta* Sars, 1885
5. *Scapholeberis kingi* Sars, 1901
6. *Simocephalus (Echinocaudus) acutirostratus* (King, 1853)
7. *S. (Coronocephalus) serrulatus* (Koch, 1841)
8. *S. (s. str.) mixtus* Sars, 1903

Bosminidae

9. *Bosmina longirostris* (O. F. Muller, 1776)
10. *Bosminopsis deitersi* Richard, 1895

Moinidae

11. *Moinodaphnia macleayi* (King, 1853)

Macrothricidae

12. *Macrothrix spinosa* King, 1853
13. *M. triserialis* (Brady, 1886)

Ilyocryptidae

14. *Ilyocryptus spinifer* Herrick, 1882

Chydoridae: Chydorinae

15. *Alonella clathratula* Sars, 1886
16. *A. excisa* (Fischer, 1854)
17. *Chydorus sphaericus* (O. F. Muller, 1776)
18. *C. ventricosus* Daday, 1898
19. *Dadaya macrops* (Daday, 1898)
20. *Disperalona caudata* Smirnov, 1996
21. *Dunhevedia crassa* King, 1853
22. *Picripleuroxus similis* Vavra, 1900
23. *Pseudochydorus globosus* (Baird, 1843)

Aloninae

24. *Alona costata* Sars, 1862
25. *A. guttata guttata* Sars, 1862
A. guttata tuberculata Kurz, 1875
26. *A. pulchella* King, 1895
27. *A. quadrangularis* (O. F. Muller, 1776)
28. *Camptocercus uncinatus* Smirnov, 1971
29. *Coronatella anodonta* (Daday, 1905)
30. *C. rectangula* (Sars, 1862)
31. *Graptoleberis testudinaria* (Fischer, 1854)
32. *Karualona karua* (King, 1853)
33. *Leberis davidi* (Richard, 1895)
34. *Oxyurella singalensis* (Daday, 1862)

30 genera of Cladocera recorded from the state of Meghalaya (Sharma & Sharma 1999; Sharma 2008), 24 genera are represented in this study. Further, among eight families of freshwater Cladocera known from India, seven are represented in our collections: the phylogenetic stem Ctenopoda belong to one family (i.e., Sididae) while Anomopoda are represented by six families (Daphniidae - Bosminidae - Moinidae - Macrothricidae - Ilyocryptidae - Chydoridae). The species-rich nature, as well as the rich higher diversity (genera and families), reflects the fairly diverse composition of the cladoceran communities of the NBR. This salient feature concurs with previous work on the faunal diversity of the Rotifera of this biosphere reserve (Sharma & Sharma 2011).

Incomplete Cladocera inventories from the conservation areas of India may not permit meaningful comparison with our report. This generalization is evident from the reports of only one species from the Kanha National Park, Madhya Pradesh (Rane 1984) and nine species from the Saipung Wild Life Sanctuary / Narpuh Reserve Forest of Meghalaya (Hattar et al. 2004). The faunal diversity is distinctly richer than the 21 species (Sharma 2010a) examined from the Bagmara Reserve Forest of Meghalaya. The richness, however, broadly compares with the reports of 31 species from the Nagerhole National Park, Tamil Nadu (Raghunathan & Rane 2001), 29 species from the Melghat Tiger Reserve, Maharashtra (Rane 2005a) and 39 species each from the Keoladelo National Park, Rajasthan (Venkataraman 1992), as well as the Nathsagar wetland and the Jaikwadi Bird Sanctuary, Maharashtra (Rane 2005b). On the other hand, the richness is distinctly lower than the reports of 45 (Sharma & Sharma 2008) and 51 (Sharma &

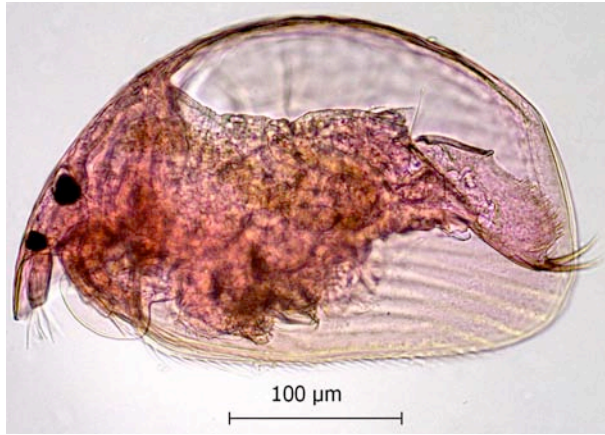


Image 1. *Coronatella anodonta* (Daday), parthenogenetic female, lateral view

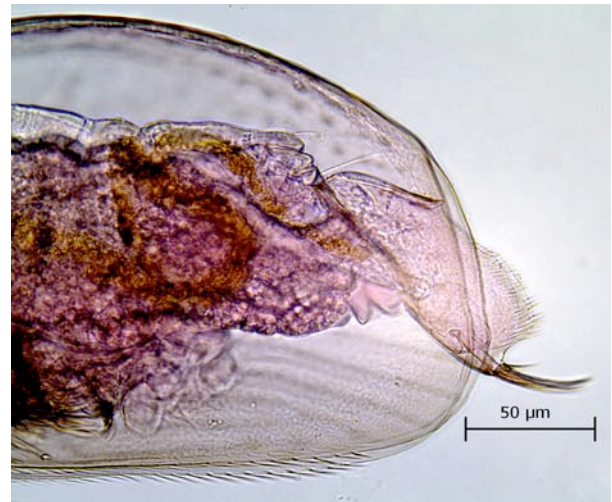


Image 2. *Coronatella anodonta* (Daday), postabdomen, lateral view



Image 3. *Disperalona caudata* Smirnov, parthenogenetic female, lateral view



Image 4. *Alonella clathratula* Sars, parthenogenetic female, lateral view

Sharma 2009) species known from two Ramsar sites of India, namely Deepor Beel (Assam) and Loktak Lake (Manipur), respectively. However, we caution against over-emphasizing the importance of the stated comparisons without considering sampling intensity and the nature of the different ecosystems.

Daday (1905) described *Alona anodonta* from Lake Gregory, but his description and illustrations were not satisfactory (refer: Rajapaksa & Fernando 1982). Rajapaksa & Fernando (1982), in turn, recorded it from Sri Lanka with proper figures as *A. cf. anodonta* Daday, 1905. Brehm (1933) examined specimens without characteristic tubercles and described them as *A. pseudoanodonta*. The former was designated as *A. pseudoanodonta anodonta* and the latter as *A. pseudoanodonta pseudoanodonta* by Smirnov (1971). Van Damme et al. (2010) termed this treatment to be incorrect as *anodonta* is an earlier described species,

and opined these to be different species which require more analysis. He also proposed to allocate them to the genus *Coronatella*. An earlier Indian report of *Coronatella anodonta* from the Keoladeo National Park (Venkataraman 1998), a Ramsar site, remains indeterminate because of the different shape of the diagnostic labrum as well as the shape and armature of its characteristic postabdomen and, hence, needs confirmation. Fernando & Kanduru (1984) listed this species in their publication on the latitudinal distribution of Cladocera on the Indian subcontinent but lacked any indication of its occurrence in India. In view of the mentioned facts, the present study (Images 1 & 2) is the first confirmed report of *Coronatella anodonta* in India.

The Australasian *Disperalona caudata* (Image 3) is a biogeographically interesting species observed

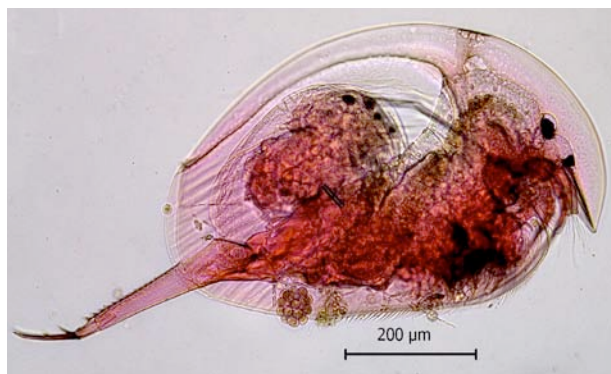


Image 5. *Camptocercus uncinatus* Smirnov, parthenogenetic female, lateral view

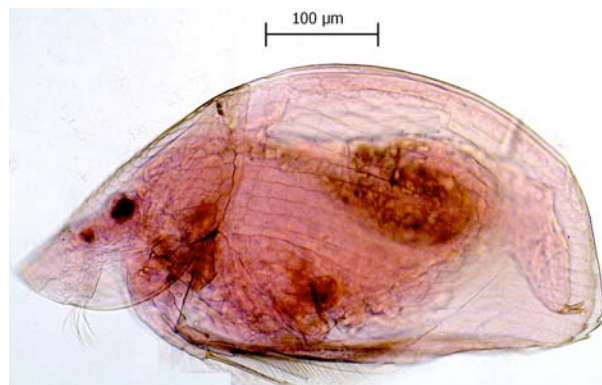


Image 6. *Graptoleberis testudinaria* (Fischer), parthenogenetic female, lateral view

from the Nokrek Biosphere Reserve. Described from Australia, this species is known outside of Australia to this date only from Thailand and northeastern India; the latter report refers to its occurrence in Assam (Sharma & Sharma 2007, 2008) while the present study extends its distributional range to the adjoining state of Meghalaya. *Alonella clathratula* (Image 4), *A. pulchella*, *A. guttata tuberculata*, *Simocephalus serrulatus*, *Camptocercus uncinatus* (Image 5), *Chydorus ventricosus* and *Graptoleberis testudinaria* (Image 6) are examples of regional distributional interest in India.

Amongst the stated species, *Alonella clathratula* was formerly treated as a subspecies of *A. excisa* by Smirnov (1971) while Smirnov (1996) subsequently resurrected its specific status based on an elongated body and postabdomen as well as a different distributional range. The former occurs in Australia, the Ethiopian and neotropical regions, and Java while *A. excisa* shows a cosmopolitan distribution. *A. clathratula* is apparently overlooked in the Indian works, until its reports from Bihar (Sharma & Sharma 2001), Assam (Sharma & Sharma 2008, 2010) and Meghalaya (Sharma 2010a). *Alona guttata tuberculata*, treated as a subspecies of *A. guttata* by Smirnov (1971), is distinctly characterized by rounded pits or tubercles on its head shield and valves. The former is known only from Europe, Columbia, and former USSR as against the nominate *Alona guttata* which apparently is a cosmopolitan species. *A. guttata tuberculata* is, however, recently documented from India from Meghalaya (Sharma 2008) and Assam (Sharma & Sharma 2010). *Simocephalus acutirostratus* appears to occur in central India and southwards (Sharma

1991) while *S. serrulatus* is so far only known from southern India, Assam and Meghalaya. The cosmopolitan *Graptoleberis testudinaria* shows a disjunct occurrence in India, with records from Kashmir, Uttaranchal, Meghalaya, Assam and Andhra Pradesh. Smirnov (1971) described *Camptocercus uncinatus* from Lake Nikolaevskoe (Russia) while Smirnov (1998) again provided a detailed description of this species to resolve taxonomic anomalies, anticipating its wider occurrence, and remarked on the need for re-examination of the reports supposed to be that of *C. australis*, in particular. The first confirmed record of *C. uncinatus* from the Indian subcontinent is provided by Sharma (2008) who proposed *C. latikae*, described by Rane (1985) from Madhya Pradesh, as its synonym. This species is so far known from this country from the states of Assam and Meghalaya. *Chydorus ventricosus*, an anomalous chydorid, was re-described by Rajapaksa & Fernando (1986). This species is known from Sri Lanka, Java, Africa and South America while it is so far observed in this country from southern, central and western India. *C. ventricosus* is recently reported (Sharma & Sharma 2010) from northeastern India from Assam and this study extends its distribution to the state of Meghalaya. Interestingly, the stated aspects indicate that the occurrence of *Alona guttata tuberculata*, *Camptocercus uncinatus* and *Chydorus ventricosus* is restricted to northeastern India. *Alona davidi* is assigned to the genus *Leberis* following Sinev et al. (2005).

The Chydoridae, the largest family of Cladocera, forms a main component (20 species, 58.8%) of the

reported species. This generalization concurs with the composition of the Indian Cladocera (Sharma 1991) and also with the faunas of various regions or states of this country. The chydorids essentially include the littoral-periphytonic species. On the contrary, the paucity of planktonic Cladocera, a distinctive feature of our study, is apparently attributed to a shallow ephemeral nature of the majority of water bodies in the study area and even the lack of distinct limnetic conditions in others. However, a few members of this category include *Bosmina longirostris*, *Bosminopsis deitersi*, *Ceriodaphnia cornuta*, and *Moinodaphnia macleayi* and these exhibit limited occurrences. *Alona costata*, *Chydorus sphaericus*, *Diaphanosoma sarsi*, *Karualona karua*, *Macrothrix triserialis* and *Simocephalus mixtus* show common occurrence and the rest of the listed species are observed in fewer samples.

Our collections show qualitative dominance of cosmopolitan species while cosmopolitan and pantropical elements are well represented. In general, the cladoceran fauna of the NBR exhibits a 'tropical character'. The stated generalization is in broader conformity with the general composition of several tropical cladoceran communities (Fernando 1980; Fernando & Kanduru 1984; Dussart et al. 1984; Sharma & Michael 1987; Sharma 1991; Sharma & Sharma 2008, 2009). The present study raises the cladoceran richness (58 species) known earlier from this state (vide Sharma & Sharma 1999; Sharma 2008, 2010a) to 61 species, the highest recorded from any state of India, and is followed by the reports from Jammu & Kashmir (59 species) > West Bengal (52 species).

The limited collections examined by us from different localities (excluding four partially sampled localities of South Garo Hills) indicate total species richness ranging from 11-24 (15±3) species and this is fairly speciose. Peak richness observed in Chiring Chirapat is followed by the reports of 22 and 21 species from Mandal Chiring and Sasategre Chiring, respectively. In addition, various localities of East, West and South Garo Hills districts indicate broadly concurrent mean richness; i.e., between 16±3, 14±3 and 14±1 species, respectively.

To sum up, the cladoceran fauna of the NBR is fairly rich and diverse, reflects a tropical character with cosmopolitan > cosmopolitan species, reveals certain biogeographically interesting species and

is characterized by distinct richness of the littoral-periphytonic members of the Chydoridae as well as a paucity of planktonic Cladocera. The fauna, however, still requires extensive future collections from the study area. Nevertheless, this study is an important contribution to our understanding of the aquatic biodiversity of the biosphere reserves and conservation areas of India.

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