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ARTHROPODA: CRUSTACEA: BRANCHIOPODA (Anostraca, Notostraca, Cyclestherida Laevicaudata and Spinicaudata)

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FAUNA OF INDIA CHECKLIST

ARTHROPODA: CRUSTACEA: BRANCHIOPODA

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Introduction: The Branchiopods are a primordial and diverse class of the subphylum Crustacea characterized by having flattened and foliaceous thoracic appendages (thoracopods); these structures have respiratory (as well as other) function and hence the name branchio- (breathing) poda (legs) (Greaves, 2012). It is a reasonably small taxon of primarily freshwater crustaceans with numerous primeval members like fairy shrimps, tadpole shrimps and encompasses highly modified associates of Cladocerans (Martin, 1992, Olesen, 2009). Nearly half of the known branchiopod species are cladocerans. The non-cladocerans (Anostraca=fairy shrimps, Notostraca=tadpole shrimps, Laevicaudata=smooth clam shrimps and Spinicaudata = Spiny clam Shrimps) are generally named as 'large branchiopods', despite the group being clearly paraphyletic, nevertheless, they share a number of common characteristics like serially similar phyllopodous trunk limbs, their preference for temporary wetlands or salt lakes (Olesen, 2009). In India many of the major groups of non-cladoceran or large branchiopods are well represented in various temporary and semi permanent water bodies, occasionally in some permanent water bodies. The anostracans, inhabiting temporary rain pools and permanent saltwater worldwide, are branchiopods lacking a carapace and with 19-27 post cephalic segments of which 9-19 carry a pair of similar, foliaceous limbs (Weekers *et al.,* 2002). Most of them are about 10-30 mm long (extreme range 5-150 mm), and consist of a long cylindrical body divided into head, thorax with many pairs of foliaceous limbs, the genitalia, and an abdomen and interestingly the fairy shrimps swim upside down (Timms, 2015).

Baird (1860) initiated the awareness of Phyllopod crustaceans of the Indian Empire by describing *Streptocephalus dichotomus* from a single male specimen swimming in a bucket of milk (Bond, 1934). Since then there are many workers who contributed to the knowledge of the non cladoceran branchiopods (Sars, 1887; Alcock, 1898; Gurney, 1906, 1921, 1924, 1925, 1930; Kemp, 1911a,b; Bond, 1934; Mahabate, 1939; Gopinath, 1944; Chako, 1950). Tiwari (1951, 1958,1962,1965, 1966,1971,1972,1996) made a significant contribution to the large branchipod crustaceans of India. The contribution made by other workers (Raj, 1951; Kulkarni, 1953; Iyengar and Basavaiah, 1956; Mathur and Sidhu, 1957; Baid, 1958, 1968, 1975; Raji,1951; Karande and Inamdar, 1959, 1961a,b; Nayar, 1965; Shull, 1967; Raj, 1971; Nayar and Nair, 1968, Shanbag and Inamdar, 1968; Issac, 1970; Malhotra and Duda, 1970;

Royan *et al*., 1970; Das, 1971; Das and Akhtar, 1971; Royan and Alfred, 1971; Royan and Sumitra, 1973; Radhakrishna and Durga Prasad, 1974, 1976; Bhargava and Alam, 1980; Munuswamy, 1982a,b; Battish, 1981, 1983; Joseph *et al.,* 1992; Belk and Esparza, 1995; Ghate and Patil, 1995; Belk and Brendonck, 1997; Ghate and Shetty, 1997; Manca and Mura, 1997) is also noteworthy.

Presently numerous remarkable investigations were carried out by Ghate, *et al*. (2003), Balaraman and Nayar (2004), Durga Prasad and Simhachalam (2004, 2009) Velu, and Munuswamy (2003, 2005,2006,2007), Babu and Nandan, (2010), Padhye *et al*. (2011a,b,c), Simhachalam and Timms (2012), Vikas *et al* (2012) and Padhye *et al*. (2015), Kulkarni *et al*.(2015), Padhye and Dahanukar (2015) and Padhye and Ghate, 2016). Rogers and Padhye (2015) reviewed the large branchiopod crustaceans of Indian subcontinent and Padhye *et al*. (2016) studied the diversity and zoogeography of the fairy shrimps of Indian subcontinent. Recently Sanoamuang et al., (2020) added *Eulimnadia cryptus* from Telengana and Padhye et al., (2023) described two new species of Leptstheriids from Goa and Karnataka.

Global Diversity: The large branchiopod crustaceans comprise about 500 species found in aquatic, inland, saline and/or temporary wetland habitats from all continents, including Antarctica (Brendonck *et al*., 2008; Rogers and Padhye, 2015).

Diversity in India: In general, the Asian large branchiopod fauna has been poorly studied and with many areas not surveyed and much confusion in the taxonomic literature (Rogers, 2013; Rogers and Padhye, 2014, 2015). Rogers and Padhye (2015) made a detailed review of large branchiopod crustaceans of Indian subcontinent (Bangladesh, India, Nepal, Pakistan, and Sri Lanka). Out of 86 species of large branchiopods known earlier from the Indian subcontinent they have recognized only 42 species: 16 anostracans, 2 notostracans, 3 laevicaudatans, 21 spinicaudatans (with reservations), and a single species of cyclestherid, while the rest were synonymized. Valarmathi (2017) in her inventory on the large branchiopod diversity in Indian Freshwater ecosystem has listed 40 species of large branchiopods belonging to 14 genera, 11 families and 4 orders reported from India. The present checklist provides a list of 43 species of large Branchiopods belonging to 14 genera and 12 families reported from various states of the country.

Diversity in Sates:

Sl. No.	State/Union Territory	No. Species	No. Endemic Species
16.	Meghalaya	0	
17.	Mizoram	0	
18.	Nagaland	0	
19.	Odisha	1	
20.	Punjab	8	
21.	Rajasthan	11	
22.	Sikkim	1	
23.	Tamil Nadu	23	
24.	Telangana	5	
25.	Tripura	0	
26.	Uttarpradesh	4	

Sl. No.	State/Union Territory	No. Species	No. Endemic Species
27.	Uttarakhand	3	
28.	West Bengal	3	
29.	Andaman & Nicobar	0	
30.	Chandigarh	0	
31.	Delhi	0	
32.	Dadra Nagar Haveli, Daman & Diu	0	
33.	Jammu & Kashmir	4	
34.	Ladakh	0	
35.	Lakshadweep	0	
36.	Puducherry	0	
1.	Andhra Pradesh	10	
2.	Arunachal Pradesh	0	
3.	Assam	0	
4.	Bihar	2	
5.	Chhattisgarh	0	
6.	Gujarat	5	
7.	Goa	2	
8.	Haryana	0	
9.	Himachal Pradesh	4	
10.	Jharkhand	0	
11.	Karnataka	3	
12.	Kerala	4	
13.	Madhaya Pradesh	3	
14.	Maharashtra	10	
15.	Manipur	0	

Endemism: Of the nearly 500 described species of large branchiopods, more than one-fourth are known only from their type localities, and several species have only been collected once or twice (Rogers, 2009). In India also many species are known only from their type locality and nearby areas and few species are reported from very limited areas.

Habitat: The anostracans inhabit almost exclusively temporary standing freshwaters like clay pans, gnammas on rock outcrops, vegetated pools, newly filled freshwater lakes, salt lakes, ephemeral farm dams, roadside ditches, disconnected creek pools, actually anywhere where water is ponded for more than few days (Timms, 2015). The tadpole shrimp *Triops* occurs in rice fields, rain pools, fishery ponds and other temporary freshwater water bodies (Zierold *et al.,* 2009, Hora *et al.,* 1955, Padhye and Ghate, 2016). The clam shrimps are also noticed in temporary and semi- permanent inland water bodies. We could observe the cyclotheriids even in permanent water bodies like ponds along with cladocerans among the marginal vegetation (Personnel observation).

Ecological Significance: They play a significant role in food chain as they become prey for many larger aquatic vertebrates and invertebrates.

Human Significance: Many species of fairy shrimps are considered as a live feed in aquaculture industries and they are used effectively as 'living pills' to provide antibiotics,

medications, or vitamins to the aqua cultural livestock (Amitha *et al.,* 2007; Basil and Pandian, 1991; Rogers, 2009). *Triops cancriformis* has been reported as a rice pest in Kashmir, India (Hora *et al,* 1955, Zaka-ur-Eab, 1984, Padhye and Ghate, 2016). On the contrary the *Triops* species are used in biological control in Japan. In pet industries *Artemia* is frequently sold as 'Sea Monkeys' and the tadpole shrimp *Triops* is sold as a 'living fossil' (Rogers, 2009). Any kind of anthropogenic activities that affects the temporary water bodies will directly or indirectly affect the diversity of large branchiopod crustaceans so if we protect the habitat we can conserve the large branchiopod crustaceans.

Threatened species as per IUCN : Of the nearly 500 described species of large branchiopods, more than one fourth are known only from their type localities, and several species have only been collected once or twice (Rogers, 2009). About 31 large branchiopod species are included in the IUCN red list and no Indian species is noticed among them (IUCN, 2016).

Protected Species as per WPA (2022) (Number of species in different schedules): Nil

Species under CITES (Number of species): Nil

Invasive alien species (Number of species): Nil

Gap areas: The works on large branchiopod crustaceans are very scattered and except the recent literature based review by Rogers and Padhye (2015) no concrete information is available in this group. Attention should be given to make a detailed taxonomic study based on the materials already collected and available in the museums and fresh faunal surveys to various parts of the country is also essential. The taxonomic ambiguity of various species of the non cladoceran branchiopods should be solved by a detailed study of the already known species and especially by examining more samples from different localities. Apart from that there are many unexplored area of this group and the youngsters should develop expertise in this group to have a better knowledge on these poorly known organisms

Systematic list:

Phylum ARTHROPODA Gravenhorst, 1843
Subphylum CRUSTACEA Brünnich, 1772
Superclass ALLOTRIOCARIDA Oakley, Wolf, Lindgren & Zaharoff, 2013
Class BRANCHIOPODA Latreille, 1817
Subclass PHYLLOPODA Preuss, 1951
Superorder CALMANOSTRACA Tasch, 1969
Order NOTOSTRACA Sars, 1867
Family TRIOPSIDAE Keilhack, 1909
Genus ***Triops*** Schrank, 1803
1. *Triops cancriformis* Schaeffer, 1756
2. *Triops granarius* Lucas, 1864
Superorder DIPLOSTRACA Gerstaecker, 1866
Order CYCLESTHERIDA Negrea, Botnariuc & Dumont, 1999
Family CYCLESTHERIIDAE Sars G.O.1900
Genus ***Cyclestheria*** Sars, 1887
3. *Cyclestheria hislopi* (Baird, 1859)
Order LAEVICAUDATA Linder, 1945
Family: LYNCEIDAE Stebbing, 1902
Genus ***Lynceus*** O.F Müller, 1776 (sensu Martin & Belk, 1988)

4. *Lynceus brachyurus* Müller, 1776
5. *Lynceus denticulatus* (Gurney, 1930) species complex
6. *Lynceus indicus* Daday, 1927

Order SPINICAUDATA Linder, 1945

Family : CYZICIDAE Stebbing, 1910

Genus ***Cyzicus*** Audouin, 1837

7. *Cyzicus ludhianatus* (Battish, 1981)

Genus ***Ozestheria*** Schwentner & Richter, in Schwentner, Just & Richter, 2015

8. *Ozestheria annandalei* Daday, 1913
9. *Ozestheria indica* (Gurney, 1906)

Family EOCYZICIDAE Schwentner, Rabet, Richter, Giribet, Padhye, Cart, Bonillo & Rogers, 2020

Genus ***Eocyzicus*** Daday, 1914 sensu Rogers et al., 2017

10. *Eocyzicus bouvieri* Daday, 1914
11. *Eocyzicus consors* (Daday, 1914)
12. *Eocyzicus hutchinsoni* Bond, 1934
13. *Eocyzicus plumosus* Royan & Sumitra, 1973
14. *Eocyzicus sahlbergi* (Simon, 1886)

Family LEPTESTHERIIDAE Daday, 1913

Genus ***Leptestheria*** Daday, 1898 sensu Daday, 1913

15. *Leptestheria chalukyae*, Padhye & Kulkarni & Pagni & Rabet, 2023
16. *Leptestheria dumonti* Subash Babu and Bijoy Nandan, 2010
17. *Leptestheria gomantaki* Padhye & Kulkarni & Pagni & Rabet, 2023
18. *Leptestheria gurneyi* Padhye & Ghate, 2016
19. *Leptestheria jaisalmarensis* Tiwari, 1962 sensu Tiwari, 1996
20. *Leptestheria nobilis* Sars, 1900
21. *Leptestheria sarsi* (Daday, 1923)
22. *Leptestheria sambharensis* (Tiwari, 1966)
23. *Leptestheria simhadrii* Simhachalam and Timms, 2012

Family LIMNADIIDAE Baird, 1849

Genus ***Eulimnadia*** Packard, 1874

24. *Eulimnadia bondi* Padhye, Rabet, Kulkarni and Pagni, 2018
25. *Eulimnadia chaperi* (Simon, 1886) (fide Padhye & Rabet 2017)
26. *Eulimnadia cryptus* Sanoamuang, Padhye, and Rogers, 2020
27. *Eulimnadia gibba* Sars, 1900
28. *Eulimnadia indocylindrova* Durga Prasad and Simhachalam, 2004 (fide Padhye et al. 2015)
29. *Eulimnadia margaretae* Bond, 1934 sensu Thiery, 1996, Rabet et al., 2015
30. *Eulimnadia michaeli* Nayar and Nair, 1968 (sensu Rogers, Dadseepai & Sanoamuang, 2026)

Subclass SARSOSTRACA

Order ANOSTRACA Sars, 1867

Suborder ANOSTRACINA, Weekers et al., 2002

Family BRANCHIPODIDAE Simon, 1886

Genus ***Branchipodopsis*** Sars,1898

31. *Branchipodopsis affinis* Sars, 1901

Family CHIROCEPHALIDAE Daday, 1910

Genus ***Chirocephalus*** Prevost, 1803 (sensu Brendonck & Belk, 1997)

32. *Chirocephalus priscus* (Daday, 1910)

Family STREPTOCEPHALIDAE Daday, 1910

Genus ***Streptocephalus* (*Streptocephalus)*** Baird, 1852

33. *Streptocephalus* (*Streptocephalus) dichotomus* Baird, 1860 (sensu Velu and Munuswamy, 2005)
34. *Streptocephalus* (*Streptocephalus) echinus* Bond, 1934 (sensu Velu and Munuswamy, 2005)
35. *Streptocephalus* (*Streptocephalus) longimanus* Bond, 1934 (sensu Velu and Munuswamy, 2005)
36. *Streptocephalus* (*Streptocephalus) sahyadriensis* Rogers and Padhye, 2014
37. *Streptocephalus* (*Streptocephalus) simplex* Gurney, 1906(sensu Velu and Munuswamy, 2005)

38. *Streptocephalus* (*Streptocephalus) spinifer* Gurney, 1906 (sensu Velu and Munuswamy, 2005)
Family THAMNOCEPHALIDAE Packard, 1883
Genus ***Branchinella*** Sayce, 1903 (sensu Rogers, 2006)
Subgenus ***Branchinella (Branchinellites)*** Daday, 1910 (sensu Rogers, 1910)
39. *Branchinella (Branchinellites) hardingi* (Qadri & Baqai, 1956)
40. *Branchinella (Branchinellites) maduraiensis* (Raj, 1951)
Genus ***Carinophallus*** Rogers, 2006
41. *Carinophallus ornata* (Daday, 1910)
Suborder ARTEMIINA Weekers et al., 2002
Family ARTEMIIDAE Grochowski, 1896
Genus ***Artemia*** Leach, 1819
42. *Artemia salina* (Linneaus, 1758)
43. *Artemia franciscana* Kellogg, 1906

[The following five species earlier reported from the country are considered as nomen dubium>uncertain: *Cyzicus politus* (Baird, 1849); *Eulimnadia compressa* (Baird, 1860) fide Padhye & Rabet, 2017; *Eulimnadia gunturensis* Radhakrishna and DurgaPrasad, 1976; *Eulimnadia similis* Sars, 1900 fide Rabet, 2010; *Eulimnadia ovata* Nayar, 1965]

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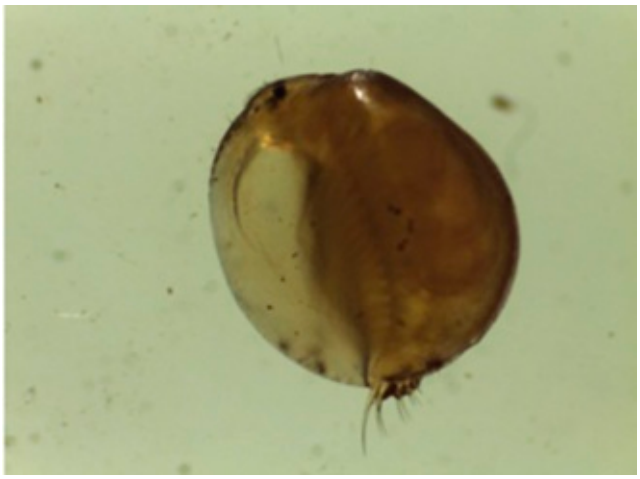
Triops granarius (Lucas, 1864)

Streptocephalus echinus Bond, 1934



Cyclestheria hislopi (Baird, 1859)

Ozestheria annandalei Daday, 1913