FAUNA OF INDIA CHECKLIST

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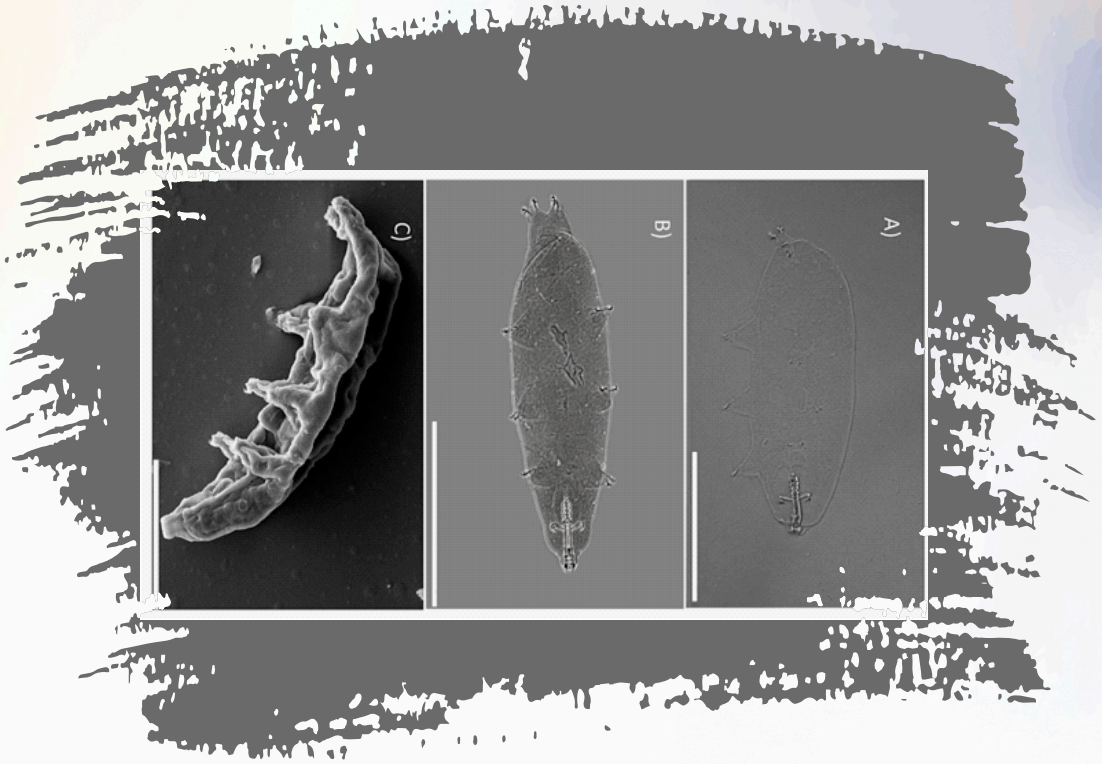

TARDIGRADA, Doyère, 1840

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ZOOLOGICAL SURVEY OF INDIA
Ministry of Environment, Forest & Climate Change

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Introduction: Phylum Tardigrada, also known as water bears or moss piglets, are fascinating microscopic animals that have captured the attention of scientists in various scientific domains, including astrobiology, ecology, and biotechnology. These small, aquatic or semi-aquatic invertebrates are characterized by their segmented bodies and four pairs of clawed legs. They are found in a wide range of environments, from marine to freshwater and terrestrial habitats, and their size ranges from less than 0.1 mm to over 1.5 mm in length. The Tardigrade's body is covered by a cuticle that protects them from desiccation and other environmental stresses.

One of the most remarkable features of Tardigrades is their unique ability to enter a state of suspended animation called cryptobiosis. During this state, their metabolic processes slow down to a near halt, allowing them to survive extreme conditions such as high temperatures, low temperatures, dehydration, exposure to UV radiation, deep sea high pressure, and heavy metal contamination. Several tardigrade species have been known to survive in cryptobiosis for many years, making them one of the most resilient organisms on the planet.

Tardigrades are being studied for their potential applications in various scientific fields, such as biotechnology, space exploration, and medicine. Due to their ability to live in extreme settings, they are being studied as models for understanding how to preserve biological materials in extreme environments. Their unique abilities have also made them a popular subject of research for scientists interested in astrobiology, as they may provide insights into the possibility of life in extreme environments, such as those found on other planets.

Moreover, Tardigrades have been used as indicators of environmental health and as a food source for other organisms in aquatic ecosystems. Their resilience to environmental stressors makes them an important organism for assessing environmental quality, as they can survive in environments that other organisms cannot.

In conclusion, Phylum Tardigrada is an intriguing group of animals that have captured the imagination of scientists in various scientific domains. Their ability to enter cryptobiosis and survive in extreme environments makes them an excellent model for studying biological preservation and resilience. Tardigrades are a testament to the incredible adaptability of life on our planet and may provide important insights into the possibilities for life in other extreme environments.

Tardigrade research in India is very limited, as sparse studies have been conducted since the 1900s. Despite their presence, tardigrades in this region is very much understudied. There is still much to learn about the distribution, ecology, and behaviour of tardigrades in India. This article aims to create an updated checklist of the tardigrades reported from India.

Global diversity*: The phylum Tardigrada is composed of 1464 species classified under 159 genera, 33 families, 5 orders and 3 classes (Degma *et al*. 2009-2023).

Diversity in India *: In the present study, we reported 56 species of Tardigrades from the India. which is classified under 4 orders, 11 families and 27 genera. Order Parachela was found to be the most diverse Tardigrades with 20 species under 10 genera reported from India.

Diversity in States :

Sl.No.	State/Union Territory	No. Species	No. Endemic Species
1	Andhra Pradesh	1	0
2	Arunachal Pradesh	0	0
3	Assam	3	0
4	Bihar	0	0
5	Chhattisgarh	0	0
6	Gujarat	0	0
7	Goa	1	0
8	Haryana	0	0
9	Himachal Pradesh	2	0
10	Jharkhand	0	0
11	Karnataka	0	0
12	Kerala	1	0
13	Madhya Pradesh	0	0
14	Maharashtra	0	0
15	Manipur	0	0
16	Meghalaya	3	0
17	Mizoram	0	0
18	Nagaland	0	0
19	Odisha	2	0
20	Punjab	0	0
21	Rajasthan	0	0
22	Sikkim	26	0
23	Tamil Nadu	6	0
24	Telangana	0	0
25	Tripura	0	0
26	Uttar Pradesh	0	0
27	Uttarakhand	1	0
28	West Bengal	8	0
29	Andaman & Nicobar	14	0
30	Chandigarh	0	0
31	Dadra Nagar Haveli, Daman & Diu	0	0
32	Delhi	0	0
33	Jammu & Kashmir	0	0
34	Ladakh	1	0
35	Lakshadweep	0	0
36	Puducherry	0	0
37	Unknwon State	4	
	INDIA TOTAL	74	**0**

Endemism: No endemic species of tardigrades were found in the studies conducted till now in India.

Habitat: They inhabit a wide range of limnoterrestrial (soil, bryophythes, lichens, algae mats) and aquatic (sediments, plants) environments ranging from the arctic to the tropics, as well as high mountain summits and deep oceans (Nelson et al., 2020). The phylum is worldwide and occupies remote and frequently hostile settings due to their resistance to adverse conditions, microscopic size, and long-distance dispersal ability.

Ecological Significance: Tardigrades have been shown to feed on bacteria, fungus, and other microbes. They contribute to the breakdown of organic material and the release of nutrients back into the ecosystem by doing so. Tardigrades are a significant source of food for many other species, including nematodes, rotifers, and insects. They are also a vital source of food for several aquatic animals, such as fish and amphibians. Tardigrades are well-known for their capacity to withstand harsh environmental conditions such as desiccation (drying out), freezing, and radiation exposure. These adaptations may provide insights into the mechanisms of survival in other organisms.

Human Significance (Economic importance, human and veterinary importance): The human significance of tardigrades lies in the potential scientific and technological applications of their unique features. For example, researchers are studying the mechanisms that allow tardigrades to survive extreme conditions, with the hope of applying this knowledge to develop new treatments for human diseases or to improve the preservation of biological samples.Tardigrades have also been studied for their ability to withstand radiation, which could have implications for space travel and the development of radiation-resistant materials.Furthermore, tardigrades have been found to produce a unique type of protein that could be used in the development of new materials, such as adhesives or coatings, that can withstand extreme conditions. Overall, while tardigrades are not directly significant to human life, their unique abilities and characteristics have the potential to contribute to important scientific and technological advancements.

Threatened species as per IUCN (Numbers under different categories)*: No species are included under IUCN as Threatened species.

Protected Species as per WPA (2022) (Number of species in different schedules)*: No species are included under any schedule as per the WPA (2022).

Species under CITES (Number of species)*: Indian tardigrades are not listed under any appendices of CITES.

Invasive alien species (Number of species)*: No Invasive tardigrades have been reported yet from India.

Gap areas (Discuss taxonomic and geographic gap areas): Despite their significance, tardigrades in India remain very much understudied, and there is a need for further research on their distribution, ecology, taxonomy and systematics.

Checklist of Indian Tardigrada

Sl No.	Family	Species
1.	Milnesiidae	*Milnesium tardigradum* Doyère, 1840:
2.		*Milnesium longiungue* Tumanov, 2006
3.	Hypsibiidae	*Hypsibius convergens* Urbanowic, 1925
4.		*Astutamen trinacriae* Arcidiacono, 1962
5.		*Adropion scoticum* Murray, 1905
6.		*Diphascon chilenense* Plate, 1888
7.		*Diphascon pingue pingue* Marcus, 1936

Sl No.	Family	Species
8.	Isohypsibiidae	*Isohypsibius schaudinni* Richters, 1909
9.		*Isohypsibius indicus* Murray, 1907
10.		*Ursulinius mihelcici* Iharos, 1964
11.		*Isohypsibius sattleri* Richters, 1902
12.	Macrobiotidae	*Calcarobiotus gildae* Maucci & Durante Pasa, 1980
13.		*Macrobiotus gemmatus* Bartoš, 1963
14.		*Macrobiotus rubens* Murray, 1907
15.		*Macrobiotus kamilae* Coughlan & Stec, 2019
16.		*Macrobiotus topali* Iharos, 1969
17.		*Macrobiotus hufelandi* Schultze, 1834
18.		*Macrobiotus echinogenitus* Richters, 1903
19.		*Macrobiotus polyopus* Marcus, 1928
20.		*Macrobiotus sapiens* Binda & Pilato, 1984
21.		*Mesobiotus coronatus* de Barros, 1942
22.		*Mesobiotus furciger* Murray, 1907
23.		*Mesobiotus harmsworthi* Murray, 1907
24.		*Mesobiotus mauccii* Pilato, 1974
25.		*Minibiotus intermedius* Plate,1888
26.		*Minibiotus furcatus* Ehrenberg, 1859
27.		*Minibiotus aculeatus* Murray, 1910
28.		*Paramacrobiotus richtersi* Murray,1911
29.		*Paramacrobiotus areolatus* Murray, 1907
30.		*Paramacrobiotus chieregoi* Maucci & Durante Pasa, 1980
31.		*Paramacrobiotus bengalensis* Basu, Babu, Siddique and Purushothaman, 2023
32.	Murrayidae	*Dactylobiotus macronyx* Dujardin, 1851
33.	Ramazzottiidae	*Ramazzottius oberhaeuseri* Doyère, 1840
34.	Halobiotidae	*Dianea acuminata* Gąsiorek, Stec, Morek & Michalczyk, 2019
35.		*Dianea sattleri* Richters, 1902
36.	Echiniscidae	*Claxtonia wendti* Richters, 1903
37.		*Echiniscus fischeri* Richters, 1911
38.		*Echiniscus testudo* Doyère, 1840
39.		*Echiniscus arctomys* Ehrenberg, 1853
40.		*Echiniscus quadrispinosus* Richters, 1902
41.		*Echiniscus brunus* Dey, Gąsiorek, & Michalczyk, 2023
42.		*Pseudechiniscus suillus* Ehrenberg, 1853
43.		*Pseudechiniscus (Meridioniscus) juanitae* de Barros, 1939
44.		*Nebularmis indicus* Gąsiorek, Ciosek & Michalczyk, 2021
45.		*Nebularmis reticulatus*Murray, 1905
46.		*Bryodelphax ortholineatus* Bartoš, 1963
47.		*Cornechiniscus madagascariensis* Maucci, 1993
48.		*Testechiniscus macronyx* Richters, 1907
49.		*Kristenseniscus kofordi* Schuster & Grigarick, 1966
50.	Stygarctidae	*Stygarctus bradypus* Schulz, 1951
51.		*Stygarctus lambertii* Grimaldi de Zio, 1987
52.		*Stygarctus keralensis* Vishnudattan, Bijoy Nandan, Hansen & Jayachandrann, 2021
53.	Batillipedidae	*Batillipes carnonensis* Fize, 1957
54.		*Batillipes kalami* Vishnudattan, Rubal & Bijoy Nandan, 2023
55.		*Batillipes chandrayaani* Vishnudattan, Rubal & Bijoy Nandan, 2024
56.	Doryphoribiidae	*Pseudobiotus Kathmanae* Nelson, Marley & bertolani, 1999

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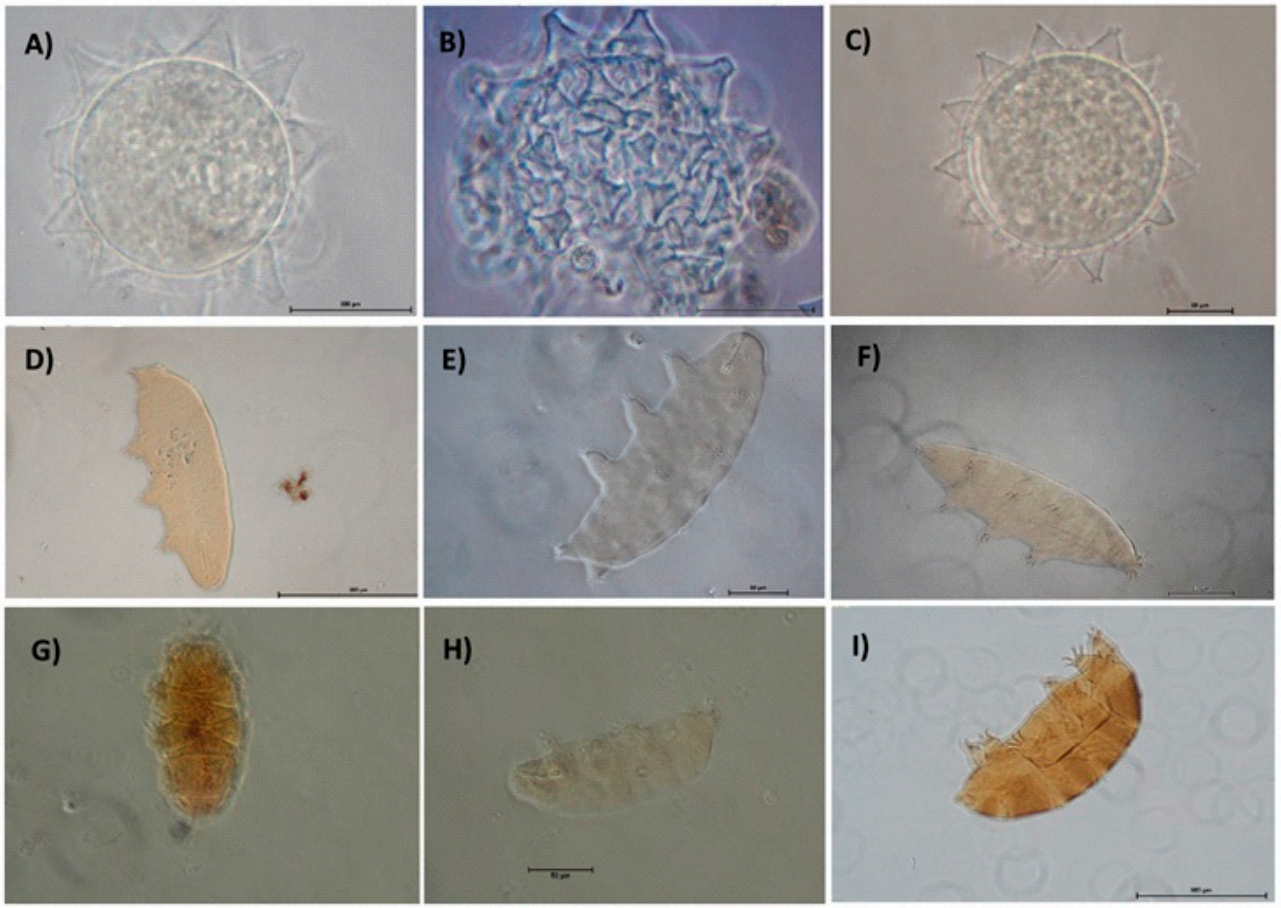
Images of the taxa



A) Egg of *Paramacrobiotus richtersi* morpho group, B) Egg of *Paramacrobiotus areolatus* morpho group, C) Egg of *Macrobiotuspallari* species complex, D) *Macrobiotus* sp. E) *Hypsibius* sp. F) *Milnesium* sp. G) *Testechniniscus* sp. H) *Minibiotus* sp. I) *Pseudechiniscus* sp.