MOLLUSCA

Chapter 32

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ABSTRACT

Freshwater molluscs play a pivotal role in the freshwater ecosystem. Globally, there are estimated 5,000 species of fresh water molluscs, of which 217 have been reported from India. This paper gives an updated nomenclature with a checklist of 150 species of gastropods and 67 species of bivalves reported from freshwater environment of various ecosystems of India. In terms of biogeographical distributions of freshwater mollusc in India, 15 species of gastropods and 18 species of bivalves have discontinuous distribution. Western Ghats is considered to be a unique biodiversity hotspot for molluscs with a record of 77 species of freshwater molluscs alone in this area. This paper along with an updated nomenclature of freshwater molluscs of India also highlights their diversity, distribution and conservation in India.

Key Words: Mollusca, Bivalves, Gastropods, Freshwater, India.

INTRODUCTION

In the freshwater environment, molluscs are an important group and their abundance plays pivotal role in freshwater ecosystem functioning (Vaughn *et al.,* 2004). Fresh water molluscs are common in ponds, lakes, paddy fields, quiet water pools, and flowing waters like lower section of perennial rivers, irrigation canals etc. Freshwater gastropods are generally found attached to submerged vegetation, rocks, sticks, bricks etc, but bivalves live partly buried in the sand or mud. Similar to the gastropods the bivalves exhibit variations in shell features depending upon the ecology of the species and may produce eco-phenotypes (Subba Rao, 1989). Molluscs form an important component of biological monitoring in terms of rating the water quality and status of aquatic systems (Strong *et al.,* 2008). Based on their occurrence, freshwater molluscs are distinguished into two- primary and secondary freshwater species. The primary freshwater molluscs are confined exclusively to the freshwater habitats, whereas secondary freshwater species are distributed both in estuarine and freshwater habitats. There are estimated 5,000 freshwater molluscs in the world for which valid descriptions exist besides 10,000 undescribed species (Balian *et al.,* 2008). A perusal of literature on malacofauna suggests that the most referred work of Preston's –Fauna of British India on the Freshwater Gastropoda and Plecypoda is nearly hundred years old and 370

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species reported from undivided India, Burma, Ceylon (Preston, 1915), and last the compilation by N.V. Subba Rao who consolidated information on freshwater molluscs and published a Handbook of Freshwater Molluscs of India in 1989 with 195 species recorded from India and adjoining areas (Subba Rao, 1989). Meanwhile, substantial information has been accumulated on freshwater molluscs of India. A number of new species, new information on their biology, range distribution etc. have been added to the list of Preston and Subba Rao. This paper therefore deals with a revised list of freshwater mollusc fauna of India along with their diversity, distribution and conservation in India.

Ideal habitat for Freshwater Mollusca

Diversity

Collections of molluscs from the Indian subcontinent are scattered far and wide. Although there are several species mentioned in literature as occurring in India, authors have taken into account only those species which could be physically verified. Nevertheless, some of the species are included on the merit of the literature. However, authors have made all efforts to present an up-to-date information for all the available species in India. The classification was followed after Bouchet and Rocroi (2005) for Gastropoda and Bouchet *et al.* (2010) for Bivalvia.

In the present work, 150 species of gastropods belonging to 51 genera and of 16 families have been ascertained to occur in India.

Table 1. A complete checklist of freshwater Mollusca with Nomenclature update

Sl. No.	Species with new classification	References effecting nomenclature
	Class GASTROPODA Order CYCLONERITIMORPHA Family NERITIDAE	
01	*Neritina pulligera* (Llinnaeus, 1767)	Rosenberg (2013)
02	*Neripteron platyconcha* (Annandale and Prashad, 1919)	Eichhorst (2016)

Sl. No.	Species with new classification	References effecting nomenclature
03	*Neripteron violaceum* (Gmelin, 1791)	Bouchet, (2016)
04	*Neripteron auriculatum* (Lamarck, 1816)	Eichhorst (2016)
05	*Neritina perottetiana* (Recluz, 1841)	Köhler & Rintelen (2011)
06	*Neritina smithii* W. Wood, 1828	Boominathan *et al.* (2012)
07	*Neritina turrita* (Gmelin, 1791)	Haynes (2005)
08	*Vittina variegata* (Lesson, 1831)	Bouchet (2016)
09	*Neritodryas subsulcata* (Sowerby, 1836)	Rintelen (2011)
10	*Clithon bicolor* (Recluz, 1842)	Eichhorst (2016)
11	*Clithon corona* (Linnaeus, 1758)	Eichhorst (2016)
12	*Clithon reticularis* (Sowerby, 1836)	Eichhorst (2016)
13	*Septaria lineata* (Lamarck, 1876)	Eichhorst (2016)
14	*Septeria porcellana* (Linnaeus, 1758)	Eichhorst (2016)
	Order ARCHITAENIOGLOSSA Family VIVIPARIDAE	
15	*Taia crassicallosa* Annandale and Rao, 1925	Tripathy & Mukhopadhyay (2014)
16	*Filopaludina bengalensis* (Lamarck, 1822)	Brandt (1974), Bouchet (2017)
17	*Bellamya crassispiralis* (Annandale, 1921)	Budha & Madhyastha (2010)
18	*Mekongia crassa* (Benson, 1836)	Budha & Daniel (2010)
19	*Idiopomadissimilis* (Mueller, 1774)	Brandt (1974), Bouchet (2015)
20	*Bellamya micron* (Annandale, 1921)	Tripathy & Mukhopadhyay (2014)
21	*Angulyagra microchaetophora* (Annandale, 1921)	Tripathy & Mukhopadhyay (2014)
22	*Angulyagra oxytropis* (Benson, 1836)	Tripathy & Mukhopadhyay (2014)
23	*Cipangopaludina lecythis* (Benson, 1836)	Lu *et al.* (2014)
	Family AMPULLARIIDAE	
24	*Pila globosa* (Swainson, 1822)	Cowie (2015)
25	*Pila scutata* var. *compacta* (Reeve, 1856)	Low *et al.* (2013)
26	*Pila theobaldi* (Hanley, 1875)	Ramakrishna and Dey, 2007, Madhyastha & Daniel (2010)
27	*Pila virens* (Lamarck, 1822)	Budha & Madhyastha(2010)
28	*Pila saxea* (Reeve, 1856)	Cowie (2015).
29	*Pomacea diffusa* Blume, 1957	Pointier (ed.)(2015)
	Family VALVATIDAE	
30	*Valvata piscinalis* (Mueller,1774)	Neubauer *et al*. (2015)
	Family LITTORINIDAE	
31	*Mainwaringia leithii* (Smith, 1876)	Reid (2010)

Sl. No.	Species with new classification	References effecting nomenclature
32	*Cremnoconchus syhadrensis* (Blanford, 1863)	Reid *et al.* (2013)
33	*Cremnoconchus canaliculatus* Blanford, 1870	Reid *et al.,* 2013
34	*Cremnoconchus conicus* (Blanford,1870)	Reid *et al.,* 2013
35	*Cremnoconchus hanumani* Reid, Aravind, Madhyastha, 2013	Reid *et al.,* 2013
36	*Cremnoconchus globulus* Reid, Aravind, Madhyastha, 2013	Reid *et al.*, 2013
37	*Cremnoconchus agumbensis* Reid, Aravind, Madhyastha, 2013	Reid *et al.*, 2013
38	*Cremnoconchus dwaraki* Reid, Aravind, Madhyastha, 2013	Reid *et al.*, 2013
39	*Cremnoconchus cingulatus* Reid, Aravind, Madhyastha, 2013	Reid *et al.*, 2013
40	*Cremnoconchus castanea* Reid, Aravind, Madhyastha, 2013	Reid *et al*., 2013
	Family HYDROBIIDAE	
41	*Indopyrgus nevilli* (Thiele, 1928)	Rintelen (2011)
42	*Bithynia tentaculata kashmirensis* (Nevill, 1884)	Gloer & Bossneck (2013)
43	*Bithynia troscheli* (Paasch, 1842) *Taxon inquirendum*	Glöer, Falniowski & Szarowska (2006)
44	*Bithynia cerameopoma* (Benson, 1830)	Bouchet (2015)
45	*Neosataria evezardi* (Blanford, 1880)	Kulkarni & Khot (2015)
46	*Bithynia pulchella* (Benson, 1836)	Bouchet (2015)
47	*Bithynia textum* Annandale, 1921	Madhyastha & Daniel (2010)
48	*Bithynia (Gabbia) orcula Frauenfeld var. producta* (Nevill,1884)	Gloer & Bossneck (2013)
49	*Bithynia stenothyroides* (Dohrn, 1857)	Bouchet (2015)
50	*Gabbia travancorica* (Benson, 1860)	Madhyastha (2011)
51	*Mysorella costigera* (Kuester,1852)	Tripathy & Mukhopadhyay (2014)
	Family POMATIOPSIDAE	
52	*Tricula gravely* Prashad,1921	Tripathy & Mukhopadhyay (2014)
53	*Tricula montana* Benson,1843	Bouchet (2013)
	Family STENOTHYRIDAE	
54	*Stenothyra blanfordiana* Nevill, 1880	Tripathy & Mukhopadhyay (2014)
55	*Stenothyra deltae* (Benson, 1836)	Tripathy & Mukhopadhyay (2014)
56	*Stenothyra foveolata* Benson,1856	Tripathy & Mukhopadhyay (2014)
57	*Stenothyra hungerfordiana* Nevill,1880	Tripathy & Mukhopadhyay (2014)

Sl. No.	Species with new classification	References effecting nomenclature
58	*Stenothyra minima* (Sowerby,1837)	Tripathy & Mukhopadhyay (2014)
59	*Stenothyra nana* Annandale and Prashad, 1921	Tripathy & Mukhopadhyay (2014)
60	*Stenothyra ornata* Annandale and Prashad, 1921	Tripathy & Mukhopadhyay (2014)
61	*Stenothyra soluta* Annandale and Prashad, 1919	Tripathy & Mukhopadhyay (2014)
62	*Stenothyra woodmasoniana* Nevill, 1880	Tripathy & Mukhopadhyay (2014)
63	*Gangetia miliacea* (Nevill, 1880)	Marshall & Bouchet (2016)
	Family IRAVADIIDAE	
64	*Iravadia annandalei* Preston, 1916	Tripathy & Mukhopadhyay (2014)
65	*Iravadia ennurensis* Preston, 1916	Tripathy & Mukhopadhyay (2014)
66	*Iravadia funerea* Preston, 1916	Tripathy & Mukhopadhyay (2014)
67	*Iravadia princeps* Preston, 1915	Tripathy & Mukhopadhyay (2014)
	Family ASSIMINEIDAE	
68	*Assiminea francessi* (Wood, 1828)	Madhyastha & Daniel (2012)
	Family THIARIDAE	
69	*Thiara amarula* (Linnaeus,1758)	Bouchet, P. (2015)
70	*Thiara rudis* (Lea,1850)	Tripathy & Mukhopadhyay (2014)
71	*Thiara scabra* (Mueller, 1774)	Glöer & Pešić(2012)
72	*Sermyla riqueti* (Grateloup,1840)	Glaubrecht, *et al*. (2009).
73	*Melanoides crebra* Lea, 1850	Tripathy & Mukhopadhyay (2014)
74	*Melanoides nevillei* (Brot, 1874)	Tripathy & Mukhopadhyay (2014)
75	*Melanoides nicobarica* (Moerch, 1859)	Tripathy & Mukhopadhyay (2014)
76	*Melanoides peddamunigalensis* Ray and Roy Chowdhury	Tripathy & Mukhopadhyay (2014)
77	*Melanoides tuberculata* (Muller, 1774)	Van Damme, & Lange, 2016.
78	*Stenomelania aspirans* (Hinds, 1874)	Glaubrecht *et al.* (2009), Glaubrecht and Podlacha (2010).
79	*Stenomelania plicaria* (Born, 1780)	Glaubrecht and Podlacha (2010).
80	*Stenomelania punctata* (Lamarck, 1822)	Glaubrecht and Podlacha (2010).
81	*Stenomelania tortulosa* (Bruguiere, 1789)	Glaubrecht and Podlacha (2010).
82	*Tarebia granifera* (Lamarck, 1822)	Pointier (ed.) (2015).
83	*Tarebia lineata* (Gray, 1828)	Tripathy & Mukhopadhyay (2014)
84	*Tarebia semigranosa* (von dem Busch, 1842)	Tripathy & Mukhopadhyay (2014)
	Family-PACHYCHILIDAE	
85	*Faunus ater* (Linnaeus,1758)	Bouchet (2015)
86	*Brotia fuscata* (Born)	Tripathy & Mukhopadhyay (2014)

Sl. No.	Species with new classification	References effecting nomenclature
87	*Brotia costula* (Rafinesque, 1833)	Bouchet (2015)
88	*Paracrostoma huegelii* (Philippi, 1841)	Kohler and Glaubrecht (2007)
89	*Paracrostoma martini* Kohler and Glaubrecht (2007)	Kohler and Glaubrecht (2007)
90	*Paracrostoma tigrina* Kohler and Glaubrecht (2007)	Kohler and Glaubrecht (2007)
	Family- PALUDOMIDAE	
91	*Paludomus annandalei* Preston, 1909	Tripathy & Mukhopadhyay (2014)
92	*Paludomus blanfordiana* Nevill, 1877	Tripathy & Mukhopadhyay (2014)
93	*Paludomus conica* (Gray, 1834) var. *kopilensis* Nevill	Tripathy & Mukhopadhyay (2014)
94	*Paludomus inflatus* Brot, 1880	Tripathy & Mukhopadhyay (2014)
95	*Paludomus obesus* (Philippi, 1842)	Tripathy & Mukhopadhyay (2014)
96	*Paludomus ornatus* Benson, 1856	Tripathy & Mukhopadhyay (2014)
97	*Paludomus pustulosa* Annandale, 1925	Tripathy & Mukhopadhyay (2014)
98	*Paludomus regulata* Benson, 1856	Tripathy & Mukhopadhyay (2014)
99	*Paludomus reticulata* Blanford, 1870	Tripathy & Mukhopadhyay (2014)
100	*Paludomus rotunda* Blanford, 1870	Tripathy & Mukhopadhyay (2014)
101	*Paludomus stephanus* (Benson, 1836)	Tripathy & Mukhopadhyay (2014)
102	*Paludomus transchauricus* (Gmelin)	Tripathy & Mukhopadhyay (2014)
103	*Paludomus sulcatus* Reeve, 1847	Tripathy & Mukhopadhyay (2014)
104	*Paludomus stomatodon* Benson, 1862	Tripathy & Mukhopadhyay (2014)
105	*Paludomus loricatus* Reeve, 1847	Tripathy & Mukhopadhyay (2014)
106	*Paludomus neritoides* Reeve, 1847	Tripathy & Mukhopadhyay (2014)
	Order HYGROPHILA Family LYMNAEIDAE	Tripathy & Mukhopadhyay (2014)
107	*Lymnaea stagnalis* (Linnaeus, 1758)	Tripathy & Mukhopadhyay (2014)
108	*Radix acuminata* (Lamarck, 1822)	Tripathy & Mukhopadhyay (2014)
109	*Radix biacuminata* (Annandale and Rao, 1925)	Tripathy & Mukhopadhyay (2014)
110	*Lymnaea horae* Annandale and Rao, 1925	Tripathy & Mukhopadhyay (2014)
111	*Lymnaea kashmirensis* Prashad,1925	Tripathy & Mukhopadhyay (2014)
112	*Radix luteola* (Lamarck, 1822)	Tripathy & Mukhopadhyay (2014)
113	*Radix ovalior* (Annandale and Prashad, 1921)	Tripathy & Mukhopadhyay (2014)
114	*Lymnaea andersoniana* (Nevill,1881)	Tripathy & Mukhopadhyay (2014)
115	*Orientogalba hookeri* (Reeve, 1850)	Tripathy & Mukhopadhyay (2014)
116	*Galba truncatula* (Mueller, 1774)	Tripathy & Mukhopadhyay (2014)
117	*Radix auricularia* (Linnaeus, 1758)	Tripathy & Mukhopadhyay (2014)

Sl. No.	Species with new classification	References effecting nomenclature
118	*Radix brevicauda* (Sowerby, 1873)	Tripathy & Mukhopadhyay (2014)
119	*Radix lagotis* (Schrank, 1803)	Tripathy & Mukhopadhyay (2014)
120	*Radix persica* (Issel, 1865)	Tripathy & Mukhopadhyay (2014)
121	*Stagnicola tungabhadraensis* Ray, 1967	Tripathy & Mukhopadhyay (2014)
	Family PHYSIDAE	
122	*Physa acuta* Draparnaud, 1805	Tripathy & Mukhopadhyay (2014)
	Family PLANORBIDAE	Tripathy & Mukhopadhyay (2014)
123	*Planorbis planorbis tangitarensis* Germain, 1918	Tripathy & Mukhopadhyay (2014)
124	*Planorbis rotundatus* Poiret, 1801	Tripathy & Mukhopadhyay (2014)
125	*Gyraulus barrackporensis* (Clessin, 1886)	Tripathy & Mukhopadhyay (2014)
126	*Gyraulus convexiusculus* (Hutton, 1849)	Tripathy & Mukhopadhyay (2014)
127	*Gyraulus euphraticus* (Mousson, 1874)	Tripathy & Mukhopadhyay (2014)
128	*Gyraulus labiatus* (Benson, 1850)	Tripathy & Mukhopadhyay (2014)
129	*Gyraulus ladacensis* Nevill,1878	Tripathy & Mukhopadhyay (2014)
130	*Gyraulus pankongensis* (von Martens, 1882)	Tripathy & Mukhopadhyay (2014)
131	*Gyraulus rotula* (Benson, 1850)	Tripathy & Mukhopadhyay (2014)
132	*Gyraulus saltensis* Germain,1922	Tripathy & Mukhopadhyay (2014)
133	*Gyraulus kosiensis* Glöer P. & Bössneck U. 2013	Tripathy & Mukhopadhyay (2014)
	Tribe Camptocerateae	Tripathy & Mukhopadhyay (2014)
134	*Camptoceras lineatum* Blanford, 1871	Tripathy & Mukhopadhyay (2014)
135	*Camptoceras subspinosum* Annandale and Prashad, 1920	Tripathy & Mukhopadhyay (2014)
136	*Camptoceras terebra* Benson,1843	Tripathy & Mukhopadhyay (2014)
	Tribe Segmentinineae	Tripathy & Mukhopadhyay (2014)
137	*Segmentina calatha* (Benson,1850)	Tripathy & Mukhopadhyay (2014)
138	*Segmentina taia* Annandale and Rao, 1925	Tripathy & Mukhopadhyay (2014)
139	*Segmentina trochoidea* (Benson, 1836)	Tripathy & Mukhopadhyay (2014)
140	*Hippeutis complanatus* (Linnaeus, 1758)	Tripathy & Mukhopadhyay (2014)
141	Intha *umbilicalis* (Benson,1836)	Tripathy & Mukhopadhyay (2014)
	Family PLANORBIDAE Subfamily BULLININAE	Tripathy & Mukhopadhyay (2014)
142	*Indoplanorbis exustus* (Deshayes, 1834)	Tripathy & Mukhopadhyay (2014)
	Subfamily BULLININAE	Tripathy & Mukhopadhyay (2014)
143	*Planorbella scalaris* Jay, 1839	Tripathy & Mukhopadhyay (2014)
144	*Planorbella duryi* (Wetherby, 1879)	Tripathy & Mukhopadhyay (2014)

Sl. No.	Species with new classification	References effecting nomenclature
	Family PLANORBIDAE Subfamily FERRISSINAE	Tripathy & Mukhopadhyay (2014)
145	Ferriss*ia baconi* (Bourguignat, 1853)	Tripathy & Mukhopadhyay (2014)
146	*Ferrissia ceylanica* (Benson, 1864)	Tripathy & Mukhopadhyay (2014)
147	*Ferrissia tenuis* (Bourguignat, 1862)	Tripathy & Mukhopadhyay (2014)
148	*Ferrissia verruca* (Benson, 1855)	Tripathy & Mukhopadhyay (2014)
149	*Ferrissia viola* Annandale and Prashad, 1923	Tripathy & Mukhopadhyay (2014)
150	*Ferrissia fivefallsiensis* Sankarappan, Chellapandian, Vimalanathan, Mani, Sundaram & Muthukalingan 2015	Sankarappan *et al.,* 2015
	Class BIVALVIA Subclass PTERIOMORPHIA Order ARCOIDA Superfamily ARCOIDEA Family ARCIDAE	
151	*Scaphula celox* Benson, 1836	Graf & Cummings (2015)
152	*Scaphula deltae* Blanford, 1867	Huber (2010), Graf & Cummings (2015)
153	*Scaphula nagarjunai* Janaki Ram and Radhakrishna, 1984	Graf & Cummings (2015)
	Subclass PALEOHETERODONTA Order UNIONOIDA Superfamily UNIONOIDEA Family UNIONIDAE Subfamily UNIONINAE	
154	*Arcidopsis footei* (Theobald, 1876)	Tripathy & Mukhopadhyay (2014)
155	*Physunio velaris* (Sowerby, 1868)	Graf & Cummings (2015)
156	*Scabies crispata* (Gould, 1843)	Graf & Cummings (2015)
157	*Solenaia soleniformis* (Benson, 1836)	Graf & Cummings (2015)
	Subfamily AMBLEMINAE (Quadrulinae) Tribe Amblemini	Graf & Cummings (2015)
158	*Lamellidens consobrinus* (Lea, 1859)	Graf & Cummings (2015)
159	*Lamellidens corrianus* (Lea, 1834)	Graf & Cummings (2015)
160	*Lamellidens generosus* (Gould, 1847)	Graf & Cummings (2015)
161	*Lamellidens jenkinsianus* (Benson, 1862) sub sp. *daccaensis* (Preston, 1912) sub.sp. *obesa* (Hanley and Theobald, 1877)	Graf & Cummings (2015)
162	*Lamellidens marginalis* (Lamarck, 1819)	Graf & Cummings (2015)

Sl. No.	Species with new classification	References effecting nomenclature
163	*Lamellidens phenchooganjensis* Preston, 1912	Graf & Cummings (2015)
164	*Parreysia annandalei* Preston, 1912	Graf & Cummings (2015)
165	*Parreysia burmanus* (Blanford, 1869)	Graf & Cummings (2015)
166	*Parreysia corbis* (Benson, 1856)	Graf & Cummings (2015)
167	*Parreysia corrugata* (Mueller, 1774)	Graf & Cummings (2015)
168	*Parreysia favidens* (Benson, 1862)	Graf & Cummings (2015)
169	*Parreysia gowhattensis* (Theobald, 1873)	Graf & Cummings (2015)
170	*Parreysia rajahensis* (Lea, 1841)	Graf & Cummings (2015)
171	*Parreysia sikkimensis* (Lea, 1859)	Graf & Cummings (2015)
172	*Parreysia smaragdites* (Benson, 1862)	Graf & Cummings (2015)
173	*Parreysia triembolus* (Benson, 1855)	Graf & Cummings (2015)
174	*Radiatula andersoniana* (Nevill, 1877)	Graf & Cummings (2015)
175	*Radiatula bonneaudi* (Eydoux, 1838)	Graf & Cummings (2015)
176	*Radiatula caerulea* (Lea, 1831)	Graf & Cummings (2015)
177	*Radiatula cylindrica* Annandale and Prashad, 1919	Graf & Cummings (2015)
178	*Radiatula involuta* (Benson, 1856)	Graf & Cummings(2015)
179	*Radiatula khadakvaslaensis* (Ray, 1966)	Graf & Cummings (2015)
180	*Radiatula lima* (Simpson, 1900)	Graf & Cummings (2015)
181	*Radiatula nuttalliana* (Lea, 1856)	Graf & Cummings (2015)
182	*Radiatula occata* (Lea, 1860)	Graf & Cummings (2015)
183	*Radiatula olivaria* (Lea, 1831)	Graf & Cummings (2015)
184	*Radiatula pachysoma* (Benson, 1862)	Graf & Cummings (2015)
185	*Radiatula shurtleffiana* (Lea, 1856)	Graf & Cummings (2015)
186	*Radiatula theobaldi* (Preston, 1912)	Graf & Cummings (2015)
187	*Lamellidens exolescens* (Gould, 1843)	Konopleva *et al.*, (2016)
	Superfamily MUTELOIDEA Family ETHERIIDAE	
188	*Pseudomulleria dalyi* (E.A. Smith)	Bogan (2010), Graf & Cummings (2015)
	Subclass HETERODONTA Super order IMPERIDENTIA Superfamily MACTRODEA Family SOLINIDAE	
189	*Neosolen aquaedulcioris* Ghosh, 1920	Huber (2010)
	Super order IMPERIDENTIA Superfamily MACTRODEA Family MACTRIDAE	
190	*Tanysiphon rivalis* Benson, 1858	Huber, (2010), Rosenberg (2015)

Sl. No.	Species with new classification	References effecting nomenclature
	Superfamily SOLENOIDEA Family PHARIDAE Subfamily NOVACULININAE	
191	*Novaculina gangetica* Benson, 1830	Rosenberg, (2015), Graf & Cumming (2015)
192	*Novaculina andamanensis* Preston,1910	Bogan (2010),Graf & Cummings (2015)
	Superfamily CORBICULOIDEA Family CYRENIDAE	
193	*Corbicula annandalei* Prashad, 1928	Graf & Cummings (2015)
194	*Corbicula assamensis* Prashad, 1928	Graf & Cummings (2015)
195	*Corbicula bensoni* Deshayes, 1854	Graf & Cummings (2015)
196	*Corbicula cashmiriensis* Deshayes, 1854	Graf & Cummings (2015)
197	*Corbicula krishnaea* Ray, 1967	Graf & Cummings (2015)
198	*Corbicula peninsularis* Prashad, 1928	Madhyastha (2014)
199	*Corbicula striatella* Deshayes, 1854	Graf & Cummings (2015)
200	*Batissa inflata* Prime, 1860	Rosenberg (2015)
201	*Batissa similis* Prime, 1859	Rosenberg (2015)
202	*Batissa violacea* Prime, 1859	Rosenberg (2015)
203	*Geloina bengalensis* (Lamarck)	Do, Budha & Daniel (2012)
204	*Geloina erosa* (Solander, 1786)	Bouchet (2014), He & Zhuang. 2013
205	*Villorita cornucopia* Prashad, 1921	OBIS (2012), Bogan (2010), Graf & Cummings (2015)
206	*Villorita corbiculoides* Prashad, 1927	Graf & Cummings (2015)
207	*Villorita cyprinoides* (Gray, 1925)	Madhyastha, 2011
	Family PISIDIIDAE (Sphaeriidae)	
208	*Pisidium casertanum* (Poli, 1791)	Clewing *et al.* (2013), Graf & Cumming (2015)
209	*Pisidium clarkeanum* G. and H. Nevill, 1871	Bolotov *et al.* (2015), Bogan (2010), Graf & Cummings (2015)
210	*Pisidium ellisi* Dance, 1967	Bogan (2010), Graf & Cummings (2015)
211	*Pisidium nevillianum* Theobald, 1876	Bogan (2010), Clewing *et al.* (2013:250), Bolotov *et al.* (2015), Graf & Cummings (2015)
212	*Pisidium mitchelli* Prashad, 1925	Bogan (2010), Graf& Cummings(2015)
213	*Pisidium atkinsonianum* Theobald, 1876.	Clewing *et al.* (2013:250), Bogan (2010), Graf & Cummings (2015)

Sl. No.	Species with new classification	References effecting nomenclature
214	*Pisidium kuiperi* Dance, 1967.	Clewing *et al.* (2013:250), Bogan (2010), Graf & Cummings (2015)
215	*Sphaerium austeni* Prashad, 1921	Bogan (2010), Graf & Cummings (2015)
216	*Sphaerium indicum* Deshayes, 1854	Bogan (2010), Graf & Cummings (2015)
217	*Sphaerium kashmirensis* Prashad, 1937	Bogan (2010), Graf & Cummings (2015)

Status of freshwater Molluscs in India:

Tripathy and Mukhopadhyay (2014) have documented 208 species of freshwater molluscs from India. In the presently updated work, nine species of mollusca have been added making the total documentation of 217 species of freshwater mollusca known from India. In India, the distribution of some of the freshwater Molluscs show discontinuous range. Some the species of gastropods *viz*. *Angulyagra oxytropis, A. microchaetophora, Filopaludina bengalensis f. balteata, Pila theobaldi, Lymnaea ovalior, L. horae,Paludomus oricatus, P.stephanus, P. reticulata, P. pustulosa, P. ornatus, P. conica v. kopiliensis ,Taia crassicallosa, Bithynia textum, Pila theobaldi,* and *Corbicula assamensis*, *Parreysia theobaldi*, *P. burmanus*, *P. nuttalliana*, *P. involuta, P. smaragdites, P. gowhattensis, P. corbis, Lamellideus exolescens, Sphaerium austeni, S. kuiperi, Camptoceras lineatum, Solenaia soleniformis, Scabis crispata,Physania velaris, Lamellidens jenkinsianus* subspecies *obesa, L. phenchooganjensis,* and *Ferrissia viola* are the bivalves which are exclusively distributed in the North eastern region of India. Their restricted distribution makes them vulnerable, threat prone and very rare.

Species *viz. Bithynia troscheli, Hippeutis complanatus, Gyraulus pankogensis, Planorbis rotundatus, P. tangitarensis, Radix auricularia, R. brevicauda, R. lagotis f. (form) costulata, R. lagotis f. defilippi, R. lagotis f. solidissima, R. lagotis f. striata, Galba truncatula, Bithynia tentaculata kashmirensis, Lymnaea stagnalis,Valvate piscinalis* are the gastropods and *Sphaerium mitchelli, S. kashmirensis, Pisidium casertanum* and *Corbicula cashmiriensis* are the bivalves which show restricted distribution from high altitude lakes, rivers of Jammu and Kashmir.

Some water bodies of Andaman and Nicobar Islands having fresh and estuarine waters which are the home of some isolated species and are no longer reported from the main land of India. We may call them as "exclusive Islands species". *Potamopyrgus nevilli, Tarebia semigranosa, Stenomelania punctata, S plicaria, S. aspirans, Melanoides nicobarica, M. nevilli, M. crebra, Thiara amarula, Stenothyra hangerfordiana, Neritodryas subsulcuta, Neritina variegata, N. turrita, Segmintina taia , Septaria porcellana, Theodoxus reticularis, T.bicolor* are the gastropods and *Battissa similis, Batissa violeciea* and *Batissa inflata* are the bivalves which are restricted in their distribution within Andaman and Nicobar group of Islands.

The Gangetic basin of West Bengal also shows isolated distribution of esturine and freshwater molluscs. *Novaculina gangetica, Tanysiphon rivalis*,

are the bivalves and *Stenothyra woodmasoniana, S. solata, S. ornata, S. nana, S. deltae, Iravadia princeps, Assiminea francesi, Neritina smithi*, *Pila globosa, Pila incrassatula, Mainwaringia paludomoidea* are the gastropods which have restricted distribution from West Bengal only.

Some of the species *viz*. *Lymnaea brevissima*, *Paludomus obesus, P. inflatus, Physa acuta, Cremnoconchus conicus, C. carinatus, C. syhadrensis* and *Bithynia everzardi* are the gastropods and *Parreysia khadakvaslaensis* and *Parreysia cylindrical* are bivalves reported from Maharastra.

Kerala backwaters, a unique, area is also home to some restricted species such as *Paludomus neritoides, P.stomatodom, P. sulcatus, P. annandalei, Iravadia funereal, I. annandalei, Villorita cornucopia* and *V. prasadhi*, which are not reported from other parts of India. Species such as *Ferrissia tenuis* from Nilgiri Hills, *Stagnicola tugabhadraensis* from Kurnool, *Scaphula nagarjunai* from Andha Pradesh, *Faunus ater* from Goa and Andaman and Nicobar Islands, *Iravadia ennurensis* from Tamil Nadu have restricted distribution. As a whole Western Ghats, a unique biodiversity hotspot have the representation of 77 species of freshwater molluscs of which *Arcidopsis footei, Paludomus inflatus, Pila saxea, Neritina perottetiana, Neritna platyconche, N. reticulata, Paracrostoma tigrina, Paracrostoma martini, Cremnochonchus* sp. and *Psedomulleria dalyii* are some of the species which are endemic to this region. *Pseudomullaria dalyii* (Family: Etheridae), an endemic, cemented bivalve confined to a couple of rivers in the central Western Ghats, is a rare Gondwana land relict found in Western Ghats (Madhyastha, 2001). Some of the species are only known from their type localities and are represented by only a few species; further data regarding their population, biology, ecology, vulnerability and rarity are not much unknown. *Corbicula krishnaea* from Krishna river, *C. annandalei* from Kerala backwater, *Tricula graveli* from the bed of Narmada river near Hosangabad of Madhya Pradesh, (Ramkrishna *et al.,* 2007) *Bellamya micron, Filopaulodina bengalensis f. colairensis* from Kolleru lake and *Gyraulus saltensis* from Punjab are some of the examples .

An analysis of the endemism of freshwater molluscs in India reveals that 49 species are endemic to India, of which 33 are gastropods and 14 are bivalves; 02 species are endemic to Andhra Pradesh, 01 to Punjab, 07 to Assam, 03 to Manipur, 01 to Megalaya, 02 to Mizoram, 13 to West Bengal, 02 to Tamil Nadu, 06 to Maharastra, 03 to Andaman and Nicobar Islands, 05 to Kerala backwater and 04 to Jammu and Kashmir. Arvind *et al.* (2010) documented a total of 60 species of freshwater molluscs comprising 52 gastropods (12 families and 23 genera) and 25 bivalve species (five families and eight genera), of which 28 species are endemic to this region. But actually, the number is not as high as documented by the earlier authors.

Conservation Status

We present a summary which is based on the assessment of IUCN Red List Categories and Criteria (IUCN 2001). Of the 217 species of freshwater molluscs identified as being present in India, 107 species are gastropods and 59 species are bivalves; 08 of the extant species do not have sufficient data to assess their risk of threats including extinction. According to a report of IUCN, seven species

(12%) are assessed as threatened which are *Cremnochonchus syhadrensis*, *C. carrinatus, Arcidopsis footei, Pseudomulleria dalyi* are assessed as endangered and *Cremnochonchus conicus, Parreysia khadakvasiensis* and *scaphula nagarjunai* are assessed as vulnerable. However, majority (88%) are assessed as Least Concern (Arvind *et al.,* 2010).

Table 2. The number of species of freshwater molluscs under each IUCN Red List Category in the Indian Region

IUCN Red List category	Number of Species
Extinct	0
Extinct in Wild	0
Critically Endangered	0
Endangered	3
Vulnerable	3
Near Threatened	1
Least Concern	119
Data Deficient	38
Total	216

Table 3. The number of species of freshwater gastropods under each IUCN Red List Category in the Indian Region.

IUCN Red List category	Number of Species
Extinct	0
Extinct in Wild	0
Critically Endangered	0
Endangered	2
Vulnerable	1
Near Threatened	0
Least Concern	75
Data Deficient	27
Total	149

Table 4. The threatened freshwater gastropods in the Indian assessment region

Family	Species	Category
LYMNAEIDAE	*Lymnaea ovalior*	VU
LITTORINIDAE	*Cremnoconchus conicus* / *Cremnoconchus carinatus*	EN
LITTORINIDAE	*Cremnoconchus syhadrensis*	EN

Table 5. The number of species of freshwater bivalves under each IUCN Red List Category in the Indian Region.

IUCN Red List category	Number of Species
Extinct	0
Extinct in Wild	0
Critically Endangered	0
Endangered	1
Vulnerable	2
Near Threatened	1
Least Concern	44
Data Deficient	11
Total	67

Table 6. The threatened freshwater bivalves in the Indian assessment region.

Family	Species	Category
ARCIDAE	*Scaphula nagarjunai*	VU
UNIONIDAE	*Parreysia khadakvasiensis*	VU
ETHERIIDAE	*Pseudomulleria dalyi*	EN
PISIIDAE	*Sphaerium austeni*	NT

Table 7. State wise distribution of freshwater molluscs in India

Sl. No.	States	Families	Genera	Species	%
1	Andaman & Nicobar Islands	10	20	51	25.24
2	West Bengal	14	21	65	32.17
3	Bihar	13	19	55	27.22
4	Odisha	11	16	40	19.80
5	Andhra Pradesh	13	24	43	21.28
6	Kerala	13	23	60	29.70
7	Maharashtra	10	19	60	29.70
8	Jammu and Kashmir	8	16	35	17.32
9	Delhi	9	12	17	8.41
10	Madhya Pradesh	7	7	25	12.37
11	Jharkhand	9	8	23	11.38
12	Sikkim	5	5	9	4.45
13	Arunachal Pradesh	4	5	5 (partly Worked out)	2.4
14	Meghalaya	10	14	43	21.28

Sl. No.	States	Families	Genera	Species	%
15	Manipur	11	16	52	26
16	Nagaland	9	16	21	10.5
17	Rajasthan	6	8	13	6.4
18	Tripura	8	14	30	14.85

As vectors, freshwater molluscs are instrumental in the transmission of many diseases in livestock and human. They are the intermediate host of many trematodes, of which schistosomiasis is reckoned as a potential threat to human population. On the other hand many larval bivalves are parasitic on gills of fishes (Ramakrisha and Dey, 2007).

Table 8. Gastropod species and nematode disease hosts

Species	Diseases
Melanoides tuberculata	Paragonimiasis, Echinostomiasis, Heterophyiasis
Tarebia granifera	Paragonimiasis, Echinostomiasis
Thiara scabra	Paragonimiasis, Echinostomiasis
Brotia costula	Paragonimiasis, Echinostomiasis
Indoplanorbis exustus	Cercarial Dermatitis, Echinostomiasis, Amphistomiasis
Gyraulus convexiusculus	Echinostomiasis, Amphistomiasis
Intha umbilicalis	Fasiolopsiasis (*Fasiolopsis buski*)
Radix acuminata	Schistosomiasis (*Schistosoma spindale)*
Radix luteola	Schistosomiasis (*Schistosoma indicum)*
Bithynia pulchella	Amphistomiasis
Lymnaea auricularia	Schistosomiasis (*Orientobitahszia turkestanicum*), Amphistomiasis
Ferrisia tenuis	Schistosomiasis (*Schistosoma haematobium)*

Conservation issues

Information on population (wild stocks) sizes and levels of exploitation is too poor to determine whether or not particular species are being seriously over-exploited. Data on the life history, abundance, productivity and rates of exploitation from specific localities are required for every species involved in the shell trade. However, anecdotal evidence suggests that conservation problems are on the increase and makes it possible to predict which areas and species are most vulnerable. Depletion of mollusca population appears to be occurring on a local basis in India. Population of molluscs in accessible areas especially close to tourist centers are more vulnerable to over-collection than those in remote areas. There are several reports of over-collecting of freshwater mollusca in West Bengal in areas where collectors concentrate their efforts in order to meet tourist demand.

Most nonmarine molluscs produce numerous planktonic larvae with great dispersal capacity and these species are to a great extent able to withstand high levels of harvesting. However, in some states, collection pressure may be so heavy that even these species are under the threat of over-exploition. Species with less "opportunistic" life histories are clearly more vulnerable**.** There are many generalizations about organism which appear to be extinction-prone. Some of the characteristics are :

1. The "basket cases" animals and plants reroute to extinction as a result of natural causes;
2. K –selected species, that is, those with long lives and low fecundity;
3. Species which live on islands;
4. Species with long geographical ranges;
5. Species near the top of the pyramid of biomass or at the end of food chain;
6. Species with little or no power of dispersal;
7. Species with large body size;
8. Species requiring climax vegetation;
9. Species with small populations and
10. Species with specialized niches.(Kay,1986)

The listed characteristics, which emerge from a variety of studies of rare and endangered species, serve as a profile for each group of organism. Several edible and commercial species falls under the category of geographically widespread species heavily exploited throughout their range. They demonstrate how heavy demand and intensive fishing can have a considerable impact on population as a whole, even though the species themselves are not at risk of extinction. Many species of "ornamental" freshwater mollusca have a restricted geographical range and are therefore vulnerable to over-collection, particularly if they occur in shallow waters. The likelihood of populations being adversely affected is also increased if the species concerned has a natural low population density and/or low reproductive potential. Some shells have become important not simply because of their shape or beautiful colour, but because of their rarity in nature. In some cases rarity may be a genuine reflection of population densities in the wild. In other cases, a species may be rare in trade simply because the bulk of the population is inaccessible.

SUMMARY

Freshwater molluscan fauna in India is very rich and forms an important part of biodiversity, comprising about 217 described species of snails. Almost all these species are native to India, and half of them i.e. nearly 118 species are endemic. Some freshwater and land molluscs which are not truly native to India *viz*. *Physa acuta,* which is an exotic species or an invasive alien species, is also known recently from India. They have become a serious pest and cause a great damage to crops and vegetables. Recently three other exotic species *viz*. *Planorbella duryi, Planorbella scalaris* and *Pomacea diffusa* have been introduced into freshwater bodies of India. The threats from them on native species are either scarce or not adequately known,

Fig. 1

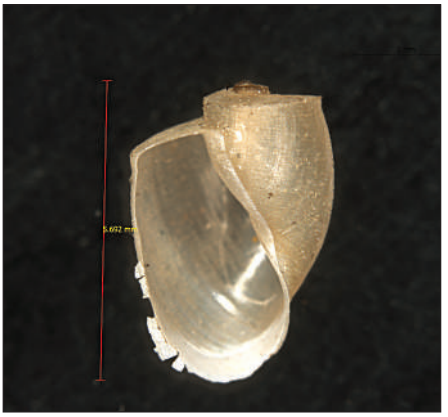

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 1-2. Dorsal and Ventral view of alien invasive species *Planorbella scalaris* (Jay, 1839)

Fig. 3-4. Dorsal and ventral view of *Physella acuta* Draparnaud; Fig. 5 Dorsal and ventral view of *Pomacea diffusa* Blume, 1957

Fig. 6. *Planorbella duryi* Top view

Fig. 7. *Planorbella duryi* Ventral view

and if they are not eradicated in time, they may alter the ecological niche of native species, eradicating them from their natural habitats.

Other ecological problems

Various activities connected with shell collecting can alter or degrade habitats. Common type of disturbance includes trampling and rock removal. Flow modification of river for construction of dam and other purposes are the threat for freshwater molluscs in India. Little attention has been paid to the consequences of selective removal of shells from the ecosystem as a whole, but problems exist. It has been observed in the exploration studies that the number of freshwater molluscs are reducing at alarming rate at polluted sites (Waghmare *et al.*2012, Verma and Saksena 2010).

Conservation measures

It is very much clear that conservation of freshwater invertebrates, including snails face particular challenges as a result of lack of awareness on the magnitude of their importance to ecosystems and human livelihoods (Dudgeon 2000a). The assessment of the impact of threats to molluscan biodiversity is further complicated by limited knowledge of freshwater mollusc fauna in the region. From the current assessment, we can anticipate a loss in biodiversity and gradual homogenization of the regional biota unless conservation action is put in place (Kholer *et al.* 2012). Reversal of these trends will require a change of focus by limnologists and water-resource managers, and also the urgent adoption of a conservation agenda in freshwater science in Asia (Dudgeon 2000a, Dudgeon *et al.,* 2006). There are several courses of action that can be taken to control trade in shells, and thus avoid over- exploitation and habitat damage. Conservation problems should not exist if the fisheries are properly managed on an ecologically sound, sustainable yield-basis. Producer countries can implement management programmes and control exports, and importing countries can control imports. The problems would also be lessened if demand for ornamental shells declined. A greater "public" awareness of the conservation issues could help in this respect.

A number of shells producing countries are now introducing legislation to control exports of shells. Exports may be controlled through a permit system, by prohibiting export of particular species or of unworked shells etc. In India twenty four species of molluscs are under Wild life Protection Act, 1972, but not any one

of them from freshwater mollusca. But it is needed to include some of the endemic and isolated species of freshwater molluscs under this act to prohibit elimination of such species from nature. Legislation prohibiting the export of unworked shells is beneficial to the country concerned because it encourages the shell craft industry which is labour intensive and increases the export value of the shells. General awareness can be increased through various seminars, symposium, short documentary films, training programmes etc. to make aware the common people, college students, school children and the enforcement departmental personnel and forest managers about the conservation of molluscs and the role or significance of molluscs in the ecosystems. Power of knowledge exercised by the common people is evidently a great tool for conservation of nature and natural resources. Freshwater molluscs species *viz.*, *Batissa spp, Parreysia* spp, *Lamelliens* spp, *Corbicula* spp, *Villorita cornucopia* and *Villoritta cyprinoides* are extensively used as food and sold by low income groups for whom freshwater resources are often vital importance in sustaining livelihood and food security. For example the Andaman tribe, Zaroas often use *Batissa* spp. as a staple food in their everyday meal. Shell fishes are consumed throughout North East India. The community people with fishing villages around Vembanad Lake in Kerala are involved in the black calm fishery (*Villorita cornucopia* and *V. cyprinoides*). For most people in these villages, the black clam is their main source of income (Kripa *et al*., 2004).

Taxonomic research is central to ecological studies and conservation, but it is one of the most neglected disciplines, especially in biodiversity rich areas. Many type localities need to be resurveyed to confirm if described, range-restricted freshwater molluscs are still present or have already become extinct and to confirm the taxonomic status of the previously described species. The lack of trained malacologists and funding has greatly hampered research on freshwater molluscs. Except for a few commonly occurring species, information on ecology, population structure and dynamics, distribution, and habitat preference of a great many species are not known.

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