
Freshwater Molluscs of India: An Insight of into Their Diversity, Distribution and Conservation

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Abstract

Freshwater molluscs are integral part of aquatic ecosystem and play an important role in the biogeochemical cycle. There are many species which are distributed both in estuarine and freshwater ecosystem. However, the endemism is high in the Western Ghats and northeastern parts of India. Also, there are intra-variations among species that make freshwater Mollusca important in terms of taxonomy. This chapter deals with thorough detailing about the available information on freshwater gastropods and bivalves of India with their economic importance and medical value as well as taxonomic detailing on the status and conservation and management of the freshwater molluscs and their habitats in India.

Keywords

Mollusca • Diversity • Endemism • Western Ghats • Conservation • India

Introduction

Molluscs are an important group for aquatic biodiversity and, where abundant, play an important role in ecosystem functioning (Vaughn et al. 2004). They form an important component of most biological monitoring programmes that rate water quality and status of aquatic systems based on invertebrate assemblages (Tonapi 1980;

Ponder 1994; Seddon 1998; Strong et al. 2008). Bivalves in particular, as they accumulate toxic substances to a greater extent than other organisms, are used to monitor water quality (Salanki et al. 2003; Bogan 2008).

Freshwater molluscs are essential to the maintenance of wetland ecosystems, primarily due to their control of water quality and nutrient balance through filter-feeding and algal-grazing and, to a lesser degree, as a food source for predators including a number of fish species, and in some parts of the world, they compose a significant food resource, especially for the rural poor and tribal. In some regions, they are one of the most threatened groups of freshwater taxa (Kay 1995).

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The impact of developments such as dams, and siltation caused by deforestation and agricultural clearance, has not been adequately researched, and there is little awareness of the complex life histories of some groups such as unionid mussels that rely on the maintenance of migratory fish runs to carry their parasitic larvae to the river headwaters. Many species are also restricted to microhabitats, such as the riffles (areas of fast current velocity, shallow depth, and broken water surface) between pools and runs (areas of rapid nonturbulent flow).

Review of Literature

Studies of freshwater molluscs of India were at their peak during the late nineteenth and early twentieth centuries. Prashad (1928) and Preston (1915) contributed much to our knowledge on the taxonomy and distribution of molluscs in the region. Later, the Zoological Survey of India surveyed northeastern Indian states and published checklists of species occurring in different states (e.g. Fauna of West Bengal, Fauna of Meghalaya and the Fauna of Tripura). Recently, Neseeman et al. (2007) contributed to our knowledge of the freshwater molluscs of the Ganga river basin in India and Nepal. However, there are some taxonomic issues that need to be addressed urgently (e.g. the species recently described by Neseeman et al. (2007) needs further clarification). The taxonomic status of several species, including *Lymnaea shanensis* and *Parreysia olivacea*, collected from lakes in Myanmar need to be verified as these species have not been collected again since they were described. There has been little recent study of molluscs across large parts of the region, including Bhutan, parts of Nepal, and Myanmar, as well as several states in India.

We have attempted here to consolidate the freshwater Mollusca of India in brief including information about their origin, ecology, distribution, identification characters, habitat, edible form and parasites, medical importance, and conservation and recommendation.

Zoogeographical Origin of Freshwater Mollusca Fauna in India

The freshwater molluscs are distinguished into two natural groups, namely, primary freshwater and secondary freshwater (Subba Rao 1989). Neseemann et al. (2007) mentioned another two that is peripheral freshwater fauna of marine origin and peripheral freshwater fauna of terrestrial origin. The primary freshwater molluscs are confined exclusively to the freshwater habitats, i.e. which have their main evolution and distribution since the Paleozoic period in continental freshwater. The secondary freshwater are those which have their main evolution and distribution since the Paleozoic period in marine habitats. They are secondarily invading freshwater habitats since carbon period (Neseemann et al. 2007). There are many species which are distributed both in estuarine and freshwaters. Such genera as *Neritina*, *Clithon*, *Septaria*, *Scaphula* and *Novaculina* belong to this category. These genera are primarily freshwater with tolerance to saline waters. The family Stenothyridae and subfamily Iravadiinae include primarily estuarine or saline water species, occasionally occurring in freshwaters. Among bivalve the genera *Villorita*, *Geloina*, *Batissa* and *Tanysiphon* are primarily estuarine, rarely occurring in freshwaters. One species of the family Assiminedae is also an estuarine species occasionally found in freshwater also.

Habitat

Freshwater molluscs are common in ponds, lakes, quiet water pools, and flowing waters like perennial rivers, irrigation canals, etc. The malacofauna of the streams may be somewhat different from that of the stagnant waters. Most of the endemic freshwater molluscs are found in the Western Ghats and Nilgiri and are remarkable for their characteristics.

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 depending upon the ecology of the species and may produce ecophenotypes (Subba Rao 1989).

Anhydrobiosis

Freshwater molluscs are usually faced with an annual dry season. Gastropods and bivalves show varying capacity to survive desiccation. Many snails can overcome this by aestivation either under dead vegetation, rocks, bricks or debris or actively burrowing at least the aperture of the shell in the mud. Some shells are capable of anaerobic respiration. With the advent of favourable conditions, the molluscs resume to their normal activities. The discontinuous and transient nature of freshwater bodies leads to isolation of snails or bivalves into small local populations. Nevertheless, much remains to be worked on the ecology of Indian freshwater molluscs.

Role of Freshwater Molluscs in the Ecosystem

Freshwater molluscs are one of the most diverse and threatened groups of animals (Vaughn et al. 2004; Lydeard et al. 2004). They are mostly unobtrusive and are not normally considered charismatic creatures, rarely attracting the attention of the popular media, unless in a negative light, as some species play a significant role (as a vector) in the transmission of human and livestock parasites and diseases (Sinha and Srivastava 1960). This is unfortunate, as they also play a key role in the provision of ecosystem services and are essential to the maintenance of wetlands, primarily due to their contribution to water quality and nutrient cycling through filter-feeding, algal-grazing, and as a food source to other animals (Strayer et al. 1999; Vaughn et al. 2004, 2008; Howard and Cuffey 2006). Some species are of high commercial value as food or ornaments (e.g. clams and some mussels and snails).

Freshwater Molluscs Used as Food

The freshwater molluscs are important as additional resources of protein for the increasing human population of our country. An increase in the shell production can augment our protein-rich food supply. It has been observed that at least 22 freshwater species are used as food and there is regular sell of shellfish in several markets of eastern (West Bengal) and northeastern states (Table 11.1). Shellfishes are harvested from the natural resources by different methods and brought to the markets. There are no regular markets in some places, but still people use the shellfish as food very frequently. It is very popular among poor and tribal people of India.

Freshwater Molluscs and Diseases

In India, millions of people and their livestock are infected with schistosomiasis, amphistomiasis, and paragonimiasis and other trematode parasites. Efforts to control schistosomiasis and other snail-borne diseases depend to a great extent on knowledge of the freshwater snails which serve as intermediate hosts for the parasites.

Freshwater molluscs are the carrier for schistosomiasis (Bilharziasis) in humans. The only report of this disease in the assessment region is in Gimi Village in Ratnagiri District of Maharashtra State (Gaitonde et al. 1981). The freshwater molluscs species *Ferrissia tenuis* (LC) (Bourguignat 1862) is a target species for control programmes against *Schistosoma haematobium*. Other species from which schistosome infection has been reported are in *L. exustus* and *L. luteola* (Table 11.2). The question of the transmission of urinary schistosomiasis elsewhere in India still remains a mystery. Future research should focus on this (Table 11.3).

Distribution

In India distribution of the freshwater molluscs shows some peculiarity that is scattered and discontinuous distribution of major species.

Table 11.1 Common use of freshwater mollusca as food and other purpose in various parts of India

Name	Common name/local name	State used as food
Gastropoda		
<i>Bellamya bengalensis</i> (Lamarck)	Googli, Ghongi (Hindi, Kurmali) Chota Genda (Ho) Rookai/Ketla/Baska (Santhali), Googli, Shamuk (Bengali) Genda Shamuk/Jal Ghanti (oriya), Thoroi (Manipur), Echalok (Garo), Mattah (Khasi), Sipuru/Dhan Samuk (Baghmara), Chenkal (Mizo), Chikangbook (Riang)	Arunachal Pradesh (Triap), Bihar, Jharkhand, Manipur, Meghalaya, Mizoram, Odisha, West Bengal
<i>Bellamya dissimilis</i> (Mueller)	Googli, Ghongi (Hindi, Kurmali) Chota Genda (Ho) Rookai/Ketla/Baska (Santhali), Googli, Shamuk (Bengali) Genda Shamuk/Jal Ghanti (oriya), Thoroi (Manipur), Echalok (Garo), Mattah (Khasi), Sipuru/Dhan Samuk (Baghmara)	Jharkhand, Bihar, Meghalaya, Odisha
<i>Angulyagra oxytropis</i> (Benson)	Thoroi (Manipur)	Manipur
<i>Cipangopaludina lecythis</i> (Benson)	Chenkal (Mizo), Chikangbook (Riang), Thoroi (Manipur)	Manipur, Mizoram
<i>Pila globosa</i> (Swainson)	Ghonga (Hindi, Kurmali, Mundari) Genda (Ho, Oriya) Marang rakai (Santhali), Shamuk (Bengali)	Bihar, Jharkhand, Odisha, West Bengal
<i>Pila theobaldi</i> (Hanley)	Yafu (Garo), Mattah (Khasi), Hamuk/Tomka Samuk (Bagmara)	Meghalaya
<i>Brotia (Antimelania) costula</i> (Rafinesque)	Mochra Samuk (Bengali), Lai Thoroi (Manipur), Echalu (Garo), Mattah (Khasi), Sipuru rodong *Baghmara	Arunachal Pradesh, Manipur, Meghalaya, West Bengal (North Bengal)
<i>Paludomus (Paludomus) blanfordiana</i> Nevill	Chenkal (Mizo), Chikangbook (Riang), Thoroi (Manipur)	Arunachal Pradesh, Manipur, Mizoram
<i>Paludomus (Paludomus) conica</i> (Gray)	Thoroi (Manipur), Achhilu (Garo), Mattah (Khasi), Sipuru/Samuk (Baghmara), Chenkal (Mizo), Chikangbook (Riang)	Arunachal Pradesh, Manipur, Meghalaya, Mizoram
<i>Paludomus (Paludomus) pustulosa</i> Annandale	Chenkal (Mizo), Chikangbook (Riang)	Mizoram
<i>Paludomus (Paludomus) regulata</i> Benson	Echalok (Garo), Mattah (Khasi), Sipuru/Samuk (Baghmara), Chenkal (Mizo), Chikangbook (Riang)	Meghalaya, Mizoram
Bivalvia		
<i>Solenia soleniformis</i> (Benson)	Tuikep (Mizo), Clampy (Beta)	Manipur
<i>Lamellidens corrianus</i> (Lea)	Chachni/Katla (Kurmali/), Sunti (Ho), Jhinuk/Samuk (Oriya), Baska/Sunti (Santhali), Jhinuk/Katli (Bengali) Kongran (Manipuri)	Bihar, Jharkhand, Orissa, West Bengal, Manipur
<i>Lamellidens generosus</i> (Gould)	Kongran (Manipur)	Manipur

<i>Lamellidens marginalis</i> (Lamarck)	Chachni/Katla (Kurmali/), Sunti (Ho), Jhinuk/Samuk (Oriya), Baska/Sunti (Santhali) Jhinuk/Katli (Bengali), Yafi (Garo), Mattah (Khasi), Jhinai (Bagmara)	Bihar, Jharkhand, Odisha, West Bengal, Meghalaya
<i>Lamellidens phenochooganiensis</i> (Preston)	Tuikep (Mizo), Clampy (Beta)	Mizoram
<i>Parreysia (Parreysia) burmanus</i> (Blanford)	Kongran (Manipur)	Manipur
<i>Parreysia (Parreysia) javidens</i> (Benson)	Chachni/Katla (Kurmali/), Sunti (Ho), Jhinuk/Samuk (Oriya), Baska/Sunti (Santhali) Jhinuk/Katli (Bengali) Kongran (Manipur), Tuikep (Mizo), Clampy (Beta)	Bihar, Jharkhand, Orissa, West Bengal, Manipur, Mizoram
<i>Parreysia (Parreysia) sikkimensis</i> (Lea)	Kongran (Manipur), Tuikep (Mizo), Clampy (Beta)	Manipur, Mizoram
<i>Parreysia (Radiatula) caerulea</i> (Lea)	Chachni/Katla (Kurmali/), Sunti (Ho), Jhinuk/Samuk (Oriya), Baska/Sunti (Santhali) Jhinuk/Katli (Bengali) Kongran (Manipur), Tuikep (Mizo), Clampy (Beta)	Bihar, Jharkhand, Orissa, West Bengal, Mizoram
<i>Parreysia (Radiatula) occata</i> (Lea)	Kongran (Manipur)	Manipur
<i>Trapezoides exolescens exolescens</i> (Gould)	Kongran (Manipur), Tuikep (Mizo), Clampy (Beta)	Manipur, Mizoram

Table 11.2 Disease associated with freshwater mollusca in India

Schistosomiasis				
Intermediate host	Host	Trematode species	Distribution	Reported by
<i>Ferrissia tenuis</i>	Man, monkey	<i>Schistosoma haematobium</i> (Bilharz)	Ratnagiri, Maharashtra	Gadgil and Shah (1952)
<i>Indoplanorbis exustus</i>	Horse, donkey, camel, sheep, goat, cattle, buffaloes, zebra, antelope	<i>Schistosoma indicum</i> Montgomery	Throughout India	Dutta and Srivastava (1955)
<i>Lymnaea luteola</i>	Dog, pig, cat, sheep, goat, rabbit, guinea pig, rat	<i>Schistosoma incognitum</i> Chandler	Uttar Pradesh, Tamil Nadu, Bihar, Jharkhand, West Bengal	Dutta and Srivastava (1955)
<i>Indoplanorbis exustus</i> , <i>Lymnaea luteola</i> , <i>Lymnaea acuminata</i>	Buffaloes, bandicoot, cattle, goat, guinea pig	<i>Schistosoma spindle</i> Montgomery	Throughout India	Dutta and Srivastava (1955)
<i>Indoplanorbis exustus</i> , <i>Lymnaea luteola</i>	Cat, buffalo, goat	<i>Schistosoma nasale</i> Rao	Throughout India	Dutta and Srivastava (1955)
<i>Lymnaea luteola</i>	Buffaloes, rabbit guinea pig, mouse	<i>Orientobilharzia dattai</i> (Dutta and Srivastava)	Bareilly (UP)	Dutta and Srivastava (1955)
<i>Lymnaea auricularia</i> , <i>Lymnaea acuminata rufescens</i>	Cattle, buffalo, goat, horse, donkey, mule, camel	<i>Orientobilharzia turkestanicum</i> (Skryabin)	Kashmir	Dutta and Srivastava (1955)
Amphistomiasis				
<i>Bithynia (Dignostoma) pulchella</i> (Benson), <i>Lymnaea auricularia</i> , <i>Lymnaea luteola</i>	Highly pathogenic to man, pig	<i>Gastrodiscoides hominis</i>	Throughout India	Mukherjee and Chauhan (1965)
<i>Indoplanorbis exustus</i>				
<i>Cyrculius convexiusculus</i>				
Paragonimiasis				
<i>Terebia granifera</i> , <i>Melanoides tuberculata</i>	Brain, spinal cord and other organs of man, cat, dog, fox, pig, goat, cattle Diseases: Jackson epilepsy, Eosinophilic meningitis and other nervous diseases	<i>Paragonimus</i> spp.	Various part of India	Mukherjee and Chauhan (1965)

Table 11.3 Medical importance of freshwater mollusca

Species	Medicinal importance	Economic importance	Reported by
<i>Bellamya</i> spp.	(1) Soup prepared from the flesh used to cure asthma, arthritis, joint swelling, rheumatism and quick healing of wound (2) The snails cleaned and kept in water for few hours and then water is used like an eye drop to cure conjunctivitis	Commonly used as food in various part of India. Mainly tribal people, lower income group and some section of middle class people taken as a food. Soft fleshy part is a very prestigious food items in some places	Dey (2008)
<i>Pila globosa</i>	Soup prepared from the eggs used to cure the rickets of the children	Used as food by the tribal and lower income group These are also valuable resource of food for ducks and hybrid Magur (fishes) in Sundarban area	Dey (2008)
<i>Lamellidens marginalis</i> , <i>Lamellidens corrianus</i>	(1) Soup prepared used to cure cardiac ailments and blood pressure (2) Curry and soup is used for faster growth and sound health (3) Shell ash after burning mixed with honey used for the remedy of giddiness, nervousness and dehydration during the summer months (4) Shell lime water used for killing of intestinal parasites	They produced the precious item pearl. These pearls are various in size and shape and having good luster	Dey (2008)
<i>Parreysia (P) favidens</i>	(1) Soup prepared used to cure cardiac ailments and blood pressure (2) Shell lime water used for killing of intestinal parasites	This species used as food by a section of tribal and lower economic people. It is also used to feed the ducks	Dey (2008)
<i>Polymesoda bengalensis</i>		This species is also economically very important. Huge quantities of these shells are collected from the different parts of Sunderbans and brought to the shell factories at canning where they powered by crushing them and used as calcium resources in poultry feed	

The freshwater gastropod fauna belongs to the clades Neritimorpha, Caenogastropoda and Heterobranchia (including the Pulmonata) (Strong et al. 2008). They are distributed in a wide range of habitats including rivers, lakes, streams, swamps, springs, temporary ponds, drainage ditches and other ephemera land seasonal waters. Highest diversity occurs in the tropics with decreasing species richness and endemism at higher latitudes (Strong et al. 2008) and altitudes. The Neritidae, Assimineidae and Iravadiidae are brackish water marine families. In the assessment region, seven species from Assimineidae and two species from Iravadiidae are represented, and they are exclusively brackish water species.

Thirteen gastropod families are in 33 genera comprising 112 species (Table 11.1) from the Caenogastropoda and Pulmonata. The Thiaridae is the most dominant family representing 19 % of species within the region followed by Planorbidae (17 %) and Lymnaeidae (9 %). In terms of genera representation, the Planorbidae has the highest number of genera with 19 %, followed by Neritidae (13 %) and Bithyniidae (13 %).

Freshwater bivalves of the India belong to five families (16 genera and 74 species). Family Unionidae is the dominant group, containing 66 % of species found in the region, followed by Sphaeriidae (21 %) and Corbiculidae (10 %) (Table 11.4). Family Solecurtidae is represented by only one species, *Novaculina gangetica*, endemic to coastal areas of West Bengal.

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 previously described species. Except for a few commonly occurring species, information on ecology, population structure, and dynamics, distribution, and habitat preference is not known. A greater degree of taxonomic research and training is also required to ensure that widely accepted taxonomic concepts are adopted. Taxonomic research is central to ecological studies and conservation, but it is one of the most neglected disciplines (Stuart et al. 2010), especially in counties rich in biodiversity but poor in resources. Training in taxonomic expertise and enhanced communication and outreach are

basic requirements of biodiversity conservation. Taxonomic knowledge of freshwater molluscs of India is severely lacking. Preston's Fauna of British India written in 1915 is still the fundamental book comprising the taxonomic account of freshwater gastropod and bivalves of the Indian subcontinent, though Subba Rao (1989) updated the taxonomic knowledge of the region. Since then the taxonomic knowledge has not been developed among regional taxonomists. There are many under- and unexplored areas that can be expected to contain both undescribed species and new populations of currently known species, but there are hardly any new descriptions of molluscs in the region in the decades that have passed since Subba Rao (1989) with few exceptions. It is possible that many of the data deficient species, and especially those that have not been re-collected since description, may be synonyms of common or widespread species when fresh material is collected for study. There is an urgent need to undertake a thorough taxonomic review of the molluscs, combined with the collection of fresh study material and research into species distributions.

Many species are widely distributed in India and its neighbouring countries. However, some species are highly restricted in distribution particularly in streams of the Western Ghats. For example, *Cremnochonchus syhadrensis*, *C. conicus*, and *C. carinatus* belong to the family Littorinidae (periwinkles) and are the only freshwater genus in an otherwise entirely marine family; they are adapted to the spray zone of perennial waterfalls from a few localities in the Karnataka and Maharashtra region of the Western Ghats. Another restricted range species is *Pseudomulleria dalyi* (Etheridae), an endemic cemented bivalve confined to couple of rivers in the central Western Ghats that is also a rare Gondwanaland relict (Madhyastha 2001). The family Etheridae shows unique discontinuous distribution, with recognized genera, viz., *Acostea* (South America), *Pseudomulleria* (India), and *Etheria* (Africa) (Smith 1898; Bogan and Hoeh 2000). The hill stream genus *Turbinicola* (Pilidae), which is an inhabitant of streams around Khandala, in Maharashtra resembles the South American hill stream genus *Asolene*, suggesting convergent

Table 11.4 Up-to-date list of species, identifying characters, their habitat and distribution

Name	Key character for identification	Habitat	Distribution
<i>Neritina (Neritina) pulligera</i> (Linn.)	The last whorl is so greatly expanded that earlier whorls are completely enclosed; wide columellar callus, outer lip with deep orange band	Found in rivers and streams, near the upper limit of tidal influence and on stones	Andaman and Nicobar Islands and Tamil Nadu
<i>Neritina (Dostia) platyconcha</i> (Annandale and Prashad)	Shell thin, translucent, broadly oval, slightly truncated posterior, columellar plate separated from the lower margin of the shell and extend more than half way across its mouth	Rivers (tidal mudflats) Feed as grazer on diatoms.	Known from type locality only (Kahadiak river)
<i>Neritina (Dostia) violacea</i> (Gmelin)	Shell thick, ovate, crepidula shape, whorls 2, spire minute anteriorly twisted inwards, protruding out as a beak; periostracum yellowish brown	Found in creeks and rivers with tidal influence, adhering to the roots and branches of the trees and also creeping on the mud flats	Andaman Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Odisha, Tamil Nadu and West Bengal
<i>Neritina (Neripteron) auriculata</i> (Lamarek)	Shell semiglobular, aperture wide, Periostracum broad and produced into two auricles or wings at the upper and lower columellar sides	The species neither survive in higher salinity nor occur in pure freshwater (tidal mudflats) of estuarine	Andaman and Nicobar Islands and Tamil Nadu
<i>Neritina (Vittina) perottetiana</i> (Recluz)	Shell semi-globose and smooth, operculum thin and externally light grey, inner columellar margin straight with 5–10 denticulation or sometimes smooth	Feed as grazer on diatoms Hill streams	Tamil Nadu (endemic to Western Ghats only)
<i>Neritina (Vittina) smithi</i> (Wood)	Shell oval, whorls 5, apex blunt, columellar margin with 13–15 teeth. Shell glistening, white or dull brown with strong black, longitudinal, undulating and interrupting lines and bands	Amphibious life style in the upper tidal zone, Gangetic estuary attached with rocks or bricks. They preferred shadowed loam and mud under dense woody riparian vegetation (Nessman 2007)	Tributaries of the Bay of Bengal, Ganga estuaries, downstream of Hughli River in West Bengal: Barrackpore
<i>Neritina (Vittina) turrita</i> (Gmelin)	Shell thick, oblong, globose, whorls 4; inner columellar margin with 16–17 distinct teeth	Tidal mud flats, attached with tree roots, coral reef boulders	Nicobar Islands: Kamorta and Car Nicobar
<i>Neritina (Vittina) variegata</i> Lesson	Shell oval, short and distinct spire, smooth surface with black spiral bands or zigzag markings, columellar callus with orange spots, inner with 8–11 denticles	Tidal mud flats attach with stones and tree roots	Andaman and Nicobar Islands
<i>Neritodryas subsulcata</i> (Sowerby)	Shell blackish brown with yellowish brown markings. Sculpture consists of conspicuous broad spiral ribs with distinct grooves in between and crossed by longitudinal striation	Tidal mud flats, attached with tree roots, coral reef boulders, stones, Jetties' wall	Andaman and Nicobar Islands

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Theodoxus (Clithon) bicolor</i> (Recluz)	Shell is generally olive green or olive brown with small dark squares and the spire is more produced	Mountain stream, attached with tree roots, coral reef boulders	Andaman and Nicobar Islands
<i>Theodoxus (Clithon) corona</i> (Linnaeus)	Shell small with shouldering body whorl, spine present or absent	Found in streams with moderate salinity	Nicobar Islands (Katchal)
<i>Theodoxus (Clithon) reticularis</i> (Sowerby)	Shell yellowish olive or green with oblique angulated red or black thin lines, often forming a coarse reticulation or network, a well-developed tooth on the inner columellar margin	Found in estuarine water rarely extending to the freshwater	West Bengal, Tamil Nadu; Porto Novo
<i>Septaria lineata</i> (Lamarck, 1816)	Cap-like shell, with the last whorl greatly expanded. The operculum reduced to a small quadrangular plate	On rocks in perennial and rapidly flowing streams near the zone of tidal influence; also found in saline water	Andaman Islands, Tamil Nadu (Coleron River) and West Bengal: 24 Parganas (South)
<i>Septaria porcellana</i> (Linnaeus)	Shell thick, apex is generally projecting beyond the posterior margin	Attached with rocks in freshwater streams	Andaman and Nicobar Islands
<i>Taia crassicallosa</i> (Annandale and Rao)	Shell globose, spire short and broad, ridges well developed; squamous tubercles, columellar callus greatly thickened	Large lakes, wetlands of northeastern region	Manipur: Imphal, Jiribam, Bishenpur, Tripura
<i>Bellamyia bengalensis</i> (Lamarck)	Shell thin, more or less smooth, with three or more colour bands; embryonic shell delicate and thin, with three primary rows of chaetae, low ridges, the lower most well developed, sometimes developing into a keel, secondary ridges bearing chaetae may develop between the primary ones	Ponds, ditches, small water bodies, rivers, streams. They are mainly benthic	Common throughout India
Form <i>typica</i>			
Form <i>annandalei</i> (Kobelt)			
Form <i>balticata</i> (Benson)			
Form <i>colairensis</i> (Annandale)			
Form <i>doliaris</i> (Gould)			
Form <i>eburnean</i> (Annandale)			
Form <i>gigantea</i> (Reeve) phase <i>halophila</i> (Kobelt)			
Form <i>mandiensis</i> (Kobelt)			
<i>Bellamyia crassispinalis</i> (Annandale)	Shell bluntly acuminate, whorls tumid, body whorl transverse and oblique, anterior margin strongly sinuate with six delicate ridges	Chakpi stream	Manipur Valley (known by type)
<i>Bellamyia crassa</i> (Benson)	Shell olive brown, globose without colour bands, spire small and blunt, shell surface sculptured with fine wavy spiral lines	Ponds, burrowing in mud or sand in shallow waters, often in groups	Andhra Pradesh, Assam, Karnataka, Meghalaya, Odisha, Gujarat, West Bengal

<i>Bellamyia dissimilis</i> (Mueller)	Spire high, narrow and swollen, body whorl with one slightly elevated ridge or broad and obscure, pale spiral band	Prefers stagnant waters, large wetlands, paddy field and even temporary water bodies. It is rarely found form river	Common throughout India Up to the elevation of 6,000 ft
<i>Bellamyia micron</i> (Ammandale)	Shell thin, transparent, small, ovately conical, finely, minutely striate; whorls 5, rounded aperture sub oval, outer lip thin	Habitat unknown	Manipur Valley (known by type)
<i>Angulyagra microchaetophora</i> (Ammandale)	Shell small, thin, imperforate, sharply acuminate, a blunt peripheral ridge on the body whorl; columellar strongly arched, outer lip sharp. Spiral whorls with two fine spiral ridges	Occurs in ponds on floating grass stems and longer part of plant that float on the water surface	Nagaland, Assam, Manipur
<i>Angulyagra oxytropis</i> (Benson)	Shell large, broadly conical, perforate with prominent spiral ridges, outer lip thin but not sharpened	Occurs in large lakes, ponds, wetland, on floating grass stems	Manipur Valley, Meghalaya, Tripura (South)
<i>Cipangopaludina lecythis</i> (Benson)	Shell olive green when fresh, spire conical, apex acuminate, whorls tumid and flattened above, suture deep, aperture large and broadly oval, outer lip sharp and tinged with black	Lakes and large wet lands	Manipur Valley (Loktak lake, Meghalaya, Tripura)
<i>Pila globosa</i> (Swainson)	Shell globose, inflated body whorl, depressed spire, suture shallow, colour bands present inside the aperture	Lives in temporary water bodies which are dry for at least one time per year. It inhabits large wetlands, pool, ditches and occasionally in the river	Assam, Bihar, Himachal Pradesh, Jharkhand, Maharashtra, Madhya Pradesh, Meghalaya, Orissa, Rajasthan, Uttar Pradesh, West Bengal
<i>Pila scutata</i> (Mousson)	Shell ovoid or semi-globose with large body whorl, spire elongated, whorls descending step-like, suture deeply impressed without carination, olivaceous green with faint brownish spiral bands in young adults	Creeks of estuarine tidal influence within mudflats	Andaman and Nicobar Islands
<i>Pila compacta</i> (Reeve)	Shell larger, thicker and stouter with strong vertical striations, columellar callus much broader, aperture more ovoid, darker in colour with faint transverse colour bands	Small pools, wetlands and sometimes in river bed; creeks of estuarine tidal influence within mudflats	Andaman and Nicobar Islands, Jharkhand
<i>Pila scutata compacta</i> (Reeve)	Shell large, whorls globose, umbilicus widely open, aperture without colour bands	Lakes, rivers, small wetlands	Manipur, Meghalaya, Tripura
<i>Pila virens</i> (Lamarck)	Body whorl highly inflated and shouldered above; spire short, suture deep and distinctly canaliculated, aperture ovate	Estuarine backwater; wet lands, lakes, pools, paddy fields	Andhra Pradesh, Kerala, Maharashtra Tamil Nadu

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Pila (Turbinicola) saxea</i> (Reeve)	Shell oblong-ovate, rather solid, with a narrow umbilicus, spire rather obtuse, whorls a little depressed round the upper part, obsolete angled and then rounded; olive, aperture pyriformly oblong, columellar lip thinly reflected	Hill streams around Khandala and Igatpuri, Western Ghat	Maharashtra
<i>Valvata piscinalis</i> (Mueller)	Shell globose, brownish yellow, whorls 5–6, deeply and narrowly umbilicate, depressed at the apex, with dense, fine longitudinal striations and faint spiral ridges	Lakes, slow running rivers	Kashmir
<i>Mainwaringia paludomoides</i> (Nevill)	Shell conical, imperforate, spire acuminate, bright yellowish brown, body whorl with three distinct, broad dark brown bands showing through the aperture, sculpture with spiral striae	Attached on the trunks and aerated root of mangroves trees submerged at high tide	Gangetic delta
<i>Cremnoconchus syhadrensis</i> (Blanford)	Shell globose, perforate, periostracum olive green to brown, whorls 4 1/2, body whorl large, suture distinct, sculptured with distinct spiral granular ridges in the upper part and fine spiral striae in the lower half, aperture oval, a broad; white band in between two brown bands inside the aperture	Hill streams	Maharashtra (Western Ghats)
<i>Cremnoconchus (Lissoconchus) carinatus</i> (Layard)	Shell ovately conical, spire short and exerted, whorls inflated, sharply keeled in the middle; sculptured with minute longitudinal striations; shell olive-yellow, marked with two indistinct broad brown bands, seen distinctly in the aperture	Hill streams	Maharashtra (Western Ghats)
<i>Cremnoconchus (Lissoconchus) conicus</i> (Blanford)	Shell ovately conical, suture distinct, angle at the periphery	Hill streams	Maharashtra (Western Ghats)
<i>Potamopyrgus (Indopyrgus) nevilli</i> (Thiele)	Shell oval, smooth; spire short and blunt, body whorl large, aperture slightly oblique, margin thickened, operculum thin, transparent and paucispiral	Estuarine creeks	Not known beyond Andaman's
<i>Bithynia tentaculata kashmirensis</i> (Nevill)	Shell conically ovate, spire more pointed, aperture pyriformly ovate	Very common in paddy fields	Kashmir
<i>Bithynia troscheli</i> (Paasch)	Shell small, ovately fusiform, suture rather deep, aperture ovate	Very common in paddy fields	Kashmir

<i>Bithynia (Digonistoma) cerameopoma</i> (Benson)	Shell oblong-ovate, whorls 5, suture impressed, umbilicus moderately narrow and deep	Stagnant shallow water of the lower Gangetic plains, such as paddy fields and oxbow lakes, occasionally occur in slow running rivers and streams	Andhra Pradesh, Assam, Bihar, Delhi, Jharkhand, Madhya Pradesh, Meghalaya, Punjab, Rajasthan, West Bengal
<i>Bithynia (Digonistoma) evezardi</i> (Blanford)	Spire conical, shell sculpture with regular close, impressed spiral lines	Stagnant shallow water, occasionally occur in slow running rivers and streams	Maharashtra
<i>Bithynia (Digonistoma) pulchella</i> (Benson)	Shell elongate, spire longer than body whorl, suture depressed, umbilicus almost closed and aperture oval	It lives in the lentic part of the rivers and wetland ponds within mud. High density also occurs within polluted water	Throughout India
<i>Bithynia (Digonistoma) textum</i> Annandale	Shell oval, whorls 4 ½, spire shorter than the body whorl	Lakes, rivers	Manipur: Thoubal (endemic to Manipur)
<i>Gabbia orcula Frauenfeld</i> Var. <i>producta</i> (Nevill)	Shell globose conic, smooth, almost imperforate, whorls 4, slightly rounded, body whorls swollen, suture deep, columellar margin not much reflected	Stagnant water with dense vegetation, e.g. wetland, small ponds and paddy fields	Andhra Pradesh, Assam, Bihar, Delhi, Jharkhand, Maharashtra, Manipur, Punjab, Rajasthan, Uttar Pradesh, West Bengal
<i>Gabbia stenothyroides</i> (Dohrn)	Shell ovate, whorls 4–5, convex, smooth, body whorl proportionately larger, spire short	Wetland, small ponds and paddy fields	Andhra Pradesh, Maharashtra, Tamil Nadu
<i>Gabbia travancorica</i> (Benson)	Shell conically globose, whorls 4 ½, columellar margin ridge-like	Stagnant water bodies and back water	Andhra Pradesh, Kerala
<i>Mysorella costigera</i> (Kuester)	Shell ornamented by strongly raised spiral ridges weaker with finer and spiral ridges between them. Shell uniformly pale horny brown	Occurring in muddy bottom in plains of Chennai	Andhra Pradesh, Karnataka, Pondicherry, Tamil Nadu
<i>Tricula gravely</i> (Prashad)	Shell elongate, suture oblique, aperture rounded, outer lip uniformly thickened	Found in still creeks of the plains, attached on weeds	Still creek among small islands in the bed of Narmada River at Hoshangabad, Madhya Pradesh
<i>Tricula montana</i> (Benson)	Shell conically ovate, suture oblique, curve, canalculated, aperture rounded, outer lip uniformly thickened	Found on the stems and leaves of aquatic plant in the stream floating through marsh at Bhimtal Lake	Assam, UttarKhand: Bhimtal
<i>Stenothyra blanfordiana</i> (Nevill)	Shell sub-ventricose, ovate, spire short, spiral whorls increasing irregularly, body whorl swollen, aperture bi-angulate, suboval	River bed within mudflats	Orissa, Tamil Nadu, West Bengal
<i>Stenothyra deltae</i> (Benson)	Shell small, thick, sculptured with spiral punctured lines; perostroacum thick and often spiral rows of spine	Found crawling on the mud at the upper region of bank of river	West Bengal

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Stenothyra foveolata</i> (Benson)	Shell ovately conical with acute apex, suture shallow, sculpture with spiral pits or punctuate markings, aperture oblique ovate	Gangetic river bed within mud	Bihar, West Bengal
<i>Stenothyra hungerfordiana</i> (Nevill)	Shell small, almost cylindrical, apex obtuse	Creeks of tidal influence	Andaman's only
<i>Stenothyra minima</i> (Sowerby)	Shell small, ovately turbinate, narrowly perforate, whorls 5, smooth, regularly increasing, body whorl convex and rapidly descending in front	Riverbeds	Gujarat, Maharashtra Orissa
<i>Stenothyra nana</i> (Prashad)	Shell ovately conical, imperforate; whorls 4, increasing very rapidly, body whorl large, sub-rhomboidal in dorsal view	Hugli River and its tributaries	West Bengal
<i>Stenothyra ornata</i> (Anandale and Prashad)	Shell imperforate, ovately conical; apex acute, spiral whorls distinctly keeled in the middle, last 4 whorls with spiral rows of blunt, flattened, blackish spines	Hugli River and its tributaries	West Bengal
<i>Stenothyra soluta</i> (Anandale and Prashad)	Shell thick, globose, with flattened spire, concave at the apex	Hugli River and its tributaries with some tidal influence	West Bengal: Gangetic delta. It is a brackish water species
<i>Stenothyra woodmasoniana</i> (Nevill)	Shell ovately conical, spire acute, concavely excavated, body whorl subangulate, flattened with rounded umbilical region; sculpture smooth or may appear malleated under large magnification	Hugli River and its tributaries with some tidal influence	West Bengal: Gangetic delta. It is a brackish water species
<i>Gangetia miliacea</i> (Nevill)	Shell minute, less than 5 mm, ovate or sub-cylindrical, aperture large, triangular area between aperture and body whorl absent	Ganga river on stony substrate and form Yamuna River at Allahabad from dense submerged macrophytes	Bihar: Patna, Kerala, Orissa, Uttar Pradesh, West Bengal
<i>Iravadia amandalei</i> (Preston)	Shell elongated, whorls 6; sculptured with indistinct, irregular, spiral lirae, interstices, not deep, transverse obsolete	Back water	Kerala: Cochin; Tamil Nadu: Emnur back water
<i>Iravadia emurensis</i> (Preston)	Whorls 5, spire less pointed, lower margin of columella not produced	Back water	Tamil Nadu: Emnur back water, Chennai
<i>Iravadia funerea</i> (Preston)	Shell fusiform, whorls 3, sculpture with coarse spiral lirae showing traces of transverse striations	Back water	Kerala: Cochin back water
<i>Iravadia princeps</i> (Preston)	Whorls 7, spire less pointed, lower margin of columella produced	Back water	West Bengal: outskirts of Kolkata

<i>Assiminea francesci</i> (Wood)	Shell elongate, apex pointed, whorls seven rapidly increasing in the width; aperture oblique, ovate, body whorl with three brown-reddish spiral bands	Estuarine species with tidal influence; it is found up to Barrackpore in Hugli River	West Bengal
<i>Thiara (Thiara) amarula</i> (Linnaeus)	Shell large, dark brown, spire decollated, body whorl longer than the spire; body whorl with crown of spines near the periphery and suture, project upwards from shoulder; strong spiral sculpture confined to the base of the shell	Creeks of tidal influence	Great Nicobar
<i>Thiara (Thiara) rudis</i> (Lea)	Whorls regularly increasing; sculptured with axial ribs and strong spiral ridges forming nodules	Prefers slow moving water	Throughout India
<i>Thiara (Thiara) scabra</i> (Mueller)	Shell with spiral ridges, sculptured with vertical ribs bearing prominent spines directed obliquely outward, spire almost equal to the body whorl	Prefers slow moving water. Occurs in slow or fast moving water as well as stagnant water	Throughout India
<i>Thiara (Sermyla) riqueti</i> (Grateloup)	Shell small, elongate, whorls 8. Regularly increasing; sculpture with undulating axial and spiral ridges	Kerala back water, slowly running low land rivers and streams with rich invertebrate fauna	Kerala: Cochin, Quilon and Trivandrum; Maharashtra: Mumbai
<i>Faunus ater</i> (Linnaeus)	Shell with a long spire, 18-20 regularly increasing, 5-6 whorls strongly striated	Water within tidal influence	Goa, Nicobar Islands
<i>Melanooides crebra</i> (Lea)	Shell sculpture with broad equidistance spiral ridges	Estuarine water within tidal influence and very low salinity	Andaman and Nicobar Islands
<i>Melanooides nevillei</i> (Brot)	Shell sculptures partly with spiral striae on lower portion of whorl and well developed on the upper whorl	Estuarine water within tidal influence and very low salinity	Andaman and Nicobar Islands
<i>Melanooides nicobarica</i> (Reeve)	Sculpture almost smooth; spiral striae on the upper whorls	Estuarine water within tidal influence and very low salinity	Andaman and Nicobar Islands
<i>Melanooides peddamunigalensis</i> (Ray and Roy Chowdhury)	Sculpture uniformly strong throughout the shell and outer lip curved at upper angle	Slowly running low land rivers and streams and other water bodies	Andhra Pradesh: Nalgonda; Tamil Nadu
<i>Melanooides tuberculata</i> (Muller)	Sculpture with vertical ribs and spiral striae, distinct and raised on the upper whorls, but flatter on the lower ones	Occurs in all possible water bodies of stagnant and slow moving freshwater ponds, tanks, canals, streams, ditches, drains, etc.	Throughout India except Kashmir
<i>Stenomelania aspirans</i> (Hinds)	Shell very slender, spire attenuated, whorls of the spire not folded, shell with fine spiral lines throughout the body	Estuarine water within tidal influence and with very low salinity	Andaman and Nicobar Islands

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Stenomelania plicaria</i> (Born)	Shell very slender, spire attenuated upper whorls of the spire strongly folded, lower ones smoother with spiral striae	Estuarine water within tidal influence and with very low salinity	Andaman and Nicobar Islands
<i>Stenomelania punctata</i> (Lamarek)	Shell without spiral ridges, broader, spire not attenuated	Estuarine water within tidal influence and with very low salinity	Andaman and Nicobar Islands
<i>Stenomelania torulosa</i> (Bruguiere)	Sculptured with strong spiral ridges, broken into rectangular nodules towards the suture	Estuarine water within tidal influence and very low salinity and sometimes occur on slow running water of canals	Andaman and Nicobar Islands, Andhra Pradesh, Tamil Nadu
<i>Tarebia granifera</i> (Lamarek)	Shell small, spire very sharp, sculptures with distinct spiral rows of nodules	Slowly running lowland rivers and streams with rich invertebrate fauna and good water quality condition	Andaman and Nicobar Islands, Andhra Pradesh, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, West Bengal
<i>Tarebia lineata</i> (Gray)	Shell with distinct dark, spiral line on the body whorl present	All types of rivers and streams in low land. Organically polluted water also prefers by this species	Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal
<i>Tarebia semigranosa</i> (von dem Busch)	Shell large, spire not very sharp, sculptured with distinct rows of granules	Estuarine water within tidal influence and with very low salinity	Andaman and Nicobar Islands
<i>Brotia (Antimelania) costula</i> (Rafinesque)	Shell high conoid or turreted, spire longer than the body whorl, aperture more or less rounded	Fast running streams and rivers of lowlands with rich invertebrate	Andhra Pradesh, Arunachal Pradesh Assam, Manipur, Meghalaya, Mizoram, Tripura
<i>Sulcospira huegeli</i> (Philippi)	Shell ovoid, conical, spire equal or less than body whorl; aperture oval, somewhat expanded at the base	Habitat not known	Uttar Pradesh, West Bengal, Assam, Karnataka, Kerala, Meghalaya
<i>Paludomus (Paludomus) annandalei</i> (Preston)	Shell conoidal, apex eroded, sculptured with coarse spiral striae below the suture and on the basal part of the whorls	Hill streams	Western Ghats
<i>Paludomus (Paludomus) blanfordiana</i> (Nevill)	Body whorl with three characteristics chocolate brown broad bands, which very distinctly visible through aperture	Brahmaputra basin and hill stream	Assam, Arunachal Pradesh, Meghalaya

<i>Paludomus (Paludomus) conica</i> (Gray) Var. <i>kopitlensis</i> (Nevill)	Shell globose conical, whorls 5, sculptured with three to four spiral ridges in the sutural region often ornamented with dark spiral bands	A few small lowland rivers and streams with pebbly, gravel or sand substrate	Meghalaya, Tripura
<i>Paludomus (Paludomus) inflatus</i> (Brot)	Body whorl abruptly enlarged and globular, flat below the suture and then arched: sculptured with distinct unequal spiral furrows	Hill streams	Kerala, Tamil Nadu
<i>Paludomus (Paludomus) obesus</i> (Philippi)	Shell globose, elongated and eroded spire; whorls depressed around the upper part, yellowish brown to olive, columellar callus thick and expanded	Hill streams	Maharashtra: Western Ghats
<i>Paludomus (Paludomus) ornatus</i> (Benson)	Shell ovately conical, spire acuminate, whorls 6, sculpture smooth except 2–3 spiral ridges in the spiral region; inside three dark bands, columella thick and arched	Hill streams	Assam: Brahmaputra valley
<i>Paludomus (Paludomus) pustulosa</i> (Ammandate)	Shell ovate, thick, uniformly black, with a tumid body whorl, sculptured with coarser longitudinal lines	Hill streams	Manipur, Mizoram
<i>Paludomus (Paludomus) regulata</i> (Benson)	Shell large, ovately globose, spire acuminate; suture deep, sculpture with groove-like spiral ridges; body whorl with 4 dark brown bands	Hill streams	Meghalaya: Garo Hills, Khasi Hills, Mizoram and West Bengal
<i>Paludomus (Paludomus) reticulata</i> (Blanford)	Shell not shouldered but sculptured with reticulate spiral striations, form axial granulation	Hill streams	Assam, Meghalaya
<i>Paludomus (Paludomus) rotunda</i> (Blanford)	Shell globose, sculptured with reticulate spiral striations, which form regular axial granules	Hill streams	Assam, Meghalaya
<i>Paludomus (Paludomus) stephanus</i> (Benson)	Whorls conspicuously shouldered, crown with short and pointed spines	Hill streams	Endemic to northeast India
<i>Paludomus (Paludomus) transchauricus</i> (Gmelin)	Shell conical, first few whorls with keeled spiral ridges; colour yellowish brown with dark brown spots running in lines and waves	Hill streams	Meghalaya: Khasi Hill, Jaintia Hill
<i>Paludomus (Philopotamius) sulcatus</i> (Reeve)	Shell ovate, prominent and eroded spire; whorls 3–5, rounded, very closely spirally grooved and intermediate ridges closely decussated with longitudinal striae	Hill streams	Andhra Pradesh, Kerala, Maharashtra, Tamil Nadu, West Bengal
<i>Paludomus (Stomatodon) stomatodon</i> (Benson)	Shell overly conical, spire rather low, aperture posteriorly angular, columellar margin broad and with distinct tooth anteriorly	Mountain streams near Kerala	Kerala: Western Ghats, Restricted to Western Ghats, Kerala

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Paludomus (Tanalia) loricatus</i> (Reeve)	Shell sculptured with prominent, nodules spiral ridges	Rapid flowing streams with slightly acidic water	Assam
<i>Paludomus (Tanalia) neritoides</i> (Reeve)	Shell oblong ovate, sculptured with fine spiral ridges; aperture large with broad columellar callus	In the bed of the river along with the mud	Kerala
<i>Lymnaea stagnalis</i> (Linnaeus)	Shell ovately turreted, yellowish horny, spire produced and sharply acuminated; whorls 5-6	Lakes, ponds, paddy fields	Kashmir
<i>Lymnaea (Pseudosuccinea) acuminata</i> (Lamarck)	Shell thin, ovate, spire short, acuminate, body whorl much inflated, a little angular above, with a large aperture	Occurs in permanent water bodies with abundant vegetation	Throughout India
Form <i>typica</i> (Lamarck)			
Form <i>brevissima</i> (Annandale and Rao)			
Form <i>chlamys</i> (Benson)			
Form <i>gracilior</i> (Martens)			
Form <i>hians</i> (Sowerby)			
Form <i>malleata</i> (Annandale and Rao)			
Form <i>patula</i> (Troschel)			
Form <i>rufescens</i> (Gray)			
<i>Lymnaea (Pseudosuccinea) biacuminata</i> (Annandale and Rao)	Shell thin, fragile, narrow and elongate spindle shaped; aperture large, ovoid; columella slightly twisted and has a broad fold; umbilicus completely occluded; sculptured with curved longitudinal striae	Occurs in permanent water bodies with abundant vegetation	Andhra Pradesh, Uttaranchal
<i>Lymnaea (Pseudosuccinea) horae</i> (Annandale and Rao)	Shell with well-developed and broader spire, with an extra half whorl of the apex; sculptures minutely decussated with numerous, close set of longitudinal striae	Found in clear water with muddy substratum, on rotten twigs of trees which were floating in water or partly embedded in mud at the bottom	Thumarkar nullah, near Railway bridge, Sorupeta, Assam
<i>Lymnaea (Pseudosuccinea) luteola</i> (Lamarck)	Shell thin, glossy, body whorl less inflated and laterally compressed a little; spire comparatively longer and gradually tapering; aperture angulately narrows above	This species are found in particular habitat. It is often found in temporary water bodies which dry up in summer and overcome the unfavourable conditions by burrowing in the mud	Throughout India
Form <i>typica</i> (Lamarck)			
Form <i>australis</i> (Annandale and Rao)			
Form <i>impura</i> (Troschel)			
Form <i>ovalis</i> (Gray)			
Form <i>succinea</i> (Deshayes)			

<i>Lymnaea (Pseudosuccinea) ovalior</i> (Annandale and Prashad)	Shell globose, oviform with a short spire. The base of the spire as broad as upper portion of the body wall	Loktak Lake	Manipur: Bishenpur
<i>Galba andersoniana</i> (Nevill)	Shell small, globosely elongated, perforate, smooth, whorls 5, spire short, columellar margin thickened and reflected covering the perforation	Found in small streams, seepages and temporary collections of water in cool and wet places	Himachal Pradesh, Kashmir
<i>Galba hookeri</i> (Reeve)	Upper margin of whorls broadly flattened; spire very short; aperture wide; columellar callous thick, columellar fold broad	Clear cold spring-feed ponds with dense chara spec. vegetation. Small- to medium-sized streams with macrophytes and detritus accumulation	Sikkim (very common in high altitude and endemic from north Himalayan region)
<i>Galba truncatula</i> (Mueller)	Shell sculptured with very fine spiral striation; columellar fold broad and forms a flat projection over the umbilicus	Found in small streams, seepages and temporary collections of water in cool and humid places. Often found outside the water bodies under wet dense vegetation	Kashmir
<i>Radix auricularia</i> (Linnaeus)	Body whorl not much inflated, spire not canalized	It is a Palaearctic species which has its distribution extended to Kashmir (Dal Lake and other water bodies near Srinagar)	Kashmir (commonly found around Acchabal)
<i>Radix brevicauda</i> (Sowerby)	Spire extremely short; body whorl greatly inflated	In lakes and slow running streams	Kashmir
<i>Radix lagotis</i> Form <i>costulata</i> (von Martens) Form <i>defilippi</i> (Issel) Form <i>solidissima</i> (Kobelt) Form <i>striata</i> (Andreae)	Spire moderately excreted; spire is larger, shape of the aperture being more or less constant	Cold water bodies, lakes	Kashmir; Ladakh: Leh
<i>Radix persica</i> (Issel)	Shell not much large, outer lip well expanded, extends beyond the body whorl posteriorly; columella distinctly reflected and twisted	It inhabits large rivers and streams, common in the Ganga river in Bihar and Uttar Pradesh. It is found in middle mountains in stony or rocky riverbeds, attach to hard substrate	Andhra Pradesh, Delhi, Himachal Pradesh; Jammu and Kashmir, Mizoram, Punjab, Uttar Pradesh
<i>Stagnicola tungabhadraensis</i> (Ray)	Shell elongate, turreted, perforate, whorls 6, rounded rapidly increasing in size, body whorl large, columella twisted and strongly reflected over the perforation	Main canal near Tungabhadra project area	Andhra Pradesh: Kurnool
<i>Physa acuta</i> (Draparnaud)	Shell moderate, ovate, sinistral, transparent but hick and sharply pointed apex; body whorl large and around	The species prefers polluted water, found commonly in irrigation channels, dams and streams in or near town and may be well adapted to undergo anhydrobiosis	Delhi, Maharashtra

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Planorbis planorbis tangitarenensis</i> (Germain)	Shell flattened, compressed and angulations not very distinct, with distinct 5 whorls	Occurs in lakes, wetlands	Kashmir
<i>Planorbis rotundatus</i> (Poiret)	Shell thick, rounded; whorls 5, gradually increasing, rounded without any angulation; aperture oval	Occurs in lakes, wetlands	Kashmir
<i>Gyraulus barrackporensis</i> (Clessin)	Whorls rapidly increasing, boy whorl more rounded and more dilated at its extremity, aperture very oblique	Various types of slow running and stagnant water bodies	Uttar Pradesh; West Bengal
<i>Gyraulus convexiusculus</i> (Hutton)	Shell small, discoidal, with 4–5 depressed whorls, umbilicus wide, transparent, periphery sub-angulate, closely and obliquely striate; aperture overtly lunate,	Various types of running and stagnant water bodies	Throughout India
<i>Gyraulus euphraticus</i> (Mousson)	Compressed body, strongly carinate, opaque, sculptured coarsely and irregularly, body whorl deviates from spiral whorl	Lakes, ponds and slowly running rivers and streams with rich plant growth	Bihar, Manipur, Jharkhand, Punjab, West Bengal
<i>Gyraulus labiatum</i> (Benson)	Body whorl with remarkable deviation from main axis, a whitish rib present within the aperture	Small- to large-sized stagnant water bodies with rich vegetation, slowly running rivers	Andhra Pradesh, Himachal Pradesh < Madhya Pradesh, Maharashtra, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal
<i>Gyraulus ladacensis</i> (Nevill)	Body whorl rounded not angular but slightly compressed in the middle towards the extremity, suture deep, umbilicus less wide, aperture obliquely ovate	Old water lakes with rich vegetation	Ladakh
<i>Gyraulus pankongensis</i> (von Martens)	Body whorl convex above and below neither carinate not angular, deeply umbilicate	Cold water lakes	Kashmir
<i>Gyraulus rotula</i> (Benson)	Aperture ovate-lunate, sculpture with longitudinal striae sometimes so strong to be called subcostal	Lakes, ponds, large water bodies with rich vegetation	Maharashtra, Uttar Pradesh
<i>Gyraulus saltensis</i> (Germain)	Body whorl very large and well dilated at the extremity, not deeply umbilicate	Salt range	Punjab
<i>Campyoceras lineatum</i> (Blanford)	Shell with strong spiral lines, whorls 2 ½, well-defined suture and angulated at its margin	Lakes, ponds and their effluents, slowly running streams with rich microphytes	Assam, Manipur: Loktak Lake, Uttar Pradesh

<i>Campioceras subspinosum</i> (Annandale and Prashad)	Shell with strong spiral; whorls 4, suture not impressed and to angular at the margin, spiral lines subspinose	Large lakes with rich vegetation	Kashmir
<i>Campioceras terebra</i> (Benson)	Shell elongated, at least 3 times as long as broad, sculpture without strong spiral lines	Large lakes with rich vegetation	Uttar Pradesh, West Bengal; Mogra (Hugli Dist)
<i>Segmentina (Polypylis) calatha</i> (Benson)	Shell conoidal, whorls rapidly increasing in size, side of the keel rounded	Common species of swamps, ponds, lakes and wetlands, in decaying plant and leaf-litter	Kashmir; Gangetic plain; widely distributed in northern India and Tripura
<i>Segmentina (Polypylis) taia</i> (Annandale and Rao)	Shell more conoidal, whorls gradually increasing in size, side of the keel forming a small angle	Lakes, large stagnant water bodies	Andaman: Port Blair
<i>Segmentina (Polypylis) trochoidea</i> (Benson)	Shell small, trochoid, whorls 3 ½, periphery more acute, umbilicus small or absent	Rare species of stagnant waters, lakes, ponds in submerged dense vegetation	Karnataka, Tamil Nadu, West Bengal
<i>Hippeutis fontanus</i> (Lightfoot)	Shell small, lenticular, much depressed, paucispiral; whorls very rapidly increasing, carinate; aperture obliquely heart shaped	Common species of swamps and wetlands, on macrophytes	Kashmir
<i>Hippeutis (Helicorbis) umbilicalis</i> (Benson)	Body whorl being abruptly wide, round, convex above, flattened below, bluntly angulate at the periphery, aperture heart shaped	Occur in ponds, lakes, swamps amidst dense vegetation	Assam, Bihar, Manipur, Uttar Pradesh; Kumaon Lake, West Bengal
<i>Indoplanorbis exustus</i> (Deshayes)	Shell large, thick, discoidal, sinistral, rounded at periphery, aperture ear shaped, suture deeply impressed	Occur in wetlands, ponds, lakes, swamps, ditches, amidst dense vegetation	Widely distributed
<i>Ferrissia baconi</i> (Bourguignat)	Apex blunt reflected to the right	It is occasionally found attached on stones or wooden material in a few lowland streams in the Ganga river	Bihar, Orissa, West Bengal
<i>Ferrissia ceylanica</i> (Benson)	Apex sharply pointed, very little reflected	Lakes	Manipur: Imphal
<i>Ferrissia tenuis</i> (Bourguignat)	Shell minute, thin opaque, fragile, sculptured smooth, aperture oblong; brown or blackish externally, dull yellow internally	Attached to stones, pebbles or floating objects in river streams with moderate flow. Breeds in the month of January. Eggs are laid singly on decaying leaves, etc., in a gelatinous mass	Nilgiri Hills, Maharashtra
<i>Ferrissia verruca</i> (Benson)	Shell suboval, small, thin, outline asymmetrical bilateral. Apex blunt, not elevated, blackish in colour	Found on floating stems, water plants and leaves in pond	Throughout India
<i>Ferrissia viola</i> (Annandale and Prashad)	Surface smooth with thin minute rugulose deposit. Dark brown or blackish in colour	Found on the lower side of floating grass stems in a small sluggish muddy stream	Manipur: Bishempur, Nagaland: Dimapur
<i>Paracrostoma tigrina</i> (Kohler and Glaubrecht) (2007)	Data not available	Hill streams	Western Ghats

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Paracrostoma martini</i> (Kohler and Glaubrecht) (2007).	Data not available	Hill streams	Western Ghats
Bivalvia			
<i>Scaphula celox</i> (Benson)	Shell small, tumid, inside of the valves white, elongately rhomboidal with a prominent keel along the diagonal teeth of the valve, hinge teeth 15–20, umbon prominent	Ponds, lakes, rivers mudflats of tidal influence	Madhya Pradesh, Orissa, West Bengal
<i>Scaphula deltae</i> (Blanford)	Strong ribs parallel to the posterior keel and far greater timidity of the valves, nearly twice as thick as the height	Ponds, lakes, rivers mudflats of tidal influence	Gangetic delta, Kolkata; Rabindra Sarobar; Orissa: Mahanadi river
<i>Scaphula nagarjunai</i> (Janaki Ram and Radhakrishna)	Shell very small, diagonal keel developed up to the extreme end of posterior extremity	Large lakes	Andhra Pradesh: Guntur, Khammam
<i>Arcidopsis footei</i> (Theobald)	Shell elongate, a strong ridge running back and down from the beaks, ventrally strongly compressed in the anterior region	River system	Western Ghats
<i>Physunio (Velunio) velaris</i> (Swierby)	Shell small, thin rather compressed; sculpture smooth; anterior extremity very narrow posterior side winged, ventral margin arcuated, raising abruptly anterior wards, beaks very acute, prominent, lunule excavated; cardinal teeth large, pale green, nacre white	Ponds, rivers, lakes	Assam
<i>Scabies crispata</i> (Gould)	Shell strongly and deeply sculptured, zigzag radial lines, with nodules; ridges transverse in the anterior region and vertical in the posterior region of the shell	Ponds, rivers, lakes	Assam: Sibsagar
<i>Solenaita soleniformis</i> (Benson)	Shell soleniformis, elongate and rather narrow; compressed, anterior end narrower; posterior end broader and sloping; hinge without teeth	Ponds, rivers, lakes	Assam: Daleswari in Barak River, Cachet; Mizoram
<i>Lamellidens consobrinus</i> (Lea)	Shell broad, dorsal margin obliquely truncate posterior end	Large wet lands, ponds, rivers beds, lakes	Andhra Pradesh, Maharashtra, Puducherry, Tamil Nadu
<i>Lamellidens corrianus</i> (Lea)	Umbon less prominent, colour uniformly dark	Ponds, rivers beds, lakes	Common throughout India
<i>Lamellidens generosus</i> (Gould)	Posterior wing well developed	River beds, ponds, small water bodies	Arunachal Pradesh, Jharkhand
<i>Lamellidens jenkinsonus</i> (Benson)	Shell transversely elongated, thick broader, umbones more distinct and convex, anterior	Upper river beds with muds	Assam: Upper Brahmaputra (Tezpur); Bihar: Bhagalpur
Sub. sp. <i>daccaensis</i> (Preston)	posterior side sloping end short and rounded		
Sub. sp. <i>obesa</i> (Hanley and Theobald)			

<i>Lamellidens marginalis</i> (Lamarck)	Umbo prominent, colour brown with a lighter band along the margin	Pools, ditches, large water bodies, rivers, lakes	Widely distributed
<i>Lamellidens phenchoogarijensis</i> (Preston)	Shell elongately ovate, less thick, umbones flat, anterior side angled, posterior margin obtusely rounded	Large water bodies, rivers, lakes	Mizoram
<i>Parreysia (Parreysia) annandalei</i> (Preston)	Shell oval, umbones rather small lateral teeth strong, curved, posterior and anterior scar small and deeply excavated	Large water bodies, rivers, lakes	Assam
<i>Parreysia (Parreysia) burmanus</i> (Blanford)	Shell ovate, solid, dark brownish, sculptured with coarse-corrugated ridges in anterior region and rather irregular nodulose in the rest	Large water bodies, rivers, lakes	Manipur: Bishenpur
<i>Parreysia (Parreysia) corbis</i> (Benson)	Shell oval, inequilateral, thin, subventricose, concentrically zoned with bluish green and ochraceous yellow	Large water bodies, rivers, lakes	Assam
<i>Parreysia (Parreysia) corrugata</i> (Mueller)	Shell elliptical to oval, smooth; umbones prominent; lunule well marked, sculptured with somewhat radiating, oblique, linear ridges, green in colour	Large water bodies, rivers, lakes	Throughout India
Subsp. <i>laevirostris</i> (Benson)			
Subsp. <i>nagpoorensis</i> (Lea)			
<i>Parreysia (Parreysia) favidens</i> (Benson)	Shell thick and heavy, inflated, with strong zigzag ribs on beak, unequilateral and angulate both on anterior and posterior margins, cardinal teeth strong and broad	Lakes, west land, ponds, pools, rivers	Andhra Pradesh, Assam, Bihar Jharkhand, Maharashtra Meghalaya, Mizoram, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal
Var. <i>assamensis</i> (Preston)			
Var. <i>chrysis</i> (Benson)			
Var. <i>deltae</i> (Benson)			
Var. <i>marcens</i> (Benson)			
Var. <i>plagiosoma</i> (Benson)			
Var. <i>viridula</i> (Benson)			
<i>Parreysia (Parreysia) gowhattensis</i> (Theobald)	Shell thick, anterior side curved and short, posterior side long and truncated and suddenly sloping on the posterior margin	Brahmaputra Basin,	Assam
<i>Parreysia (Parreysia) rajdhensis</i> (Lea)	Shell triangular, inflated, posteriorly angulated; umbo elevated, pointed; sculptured with prominent growth lines	River bed, wet land	Narmada River, Ramn of Kutch; Sepree and Sahib Ganj; West Bengal; Kolkata
<i>Parreysia (Parreysia) sikkimensis</i> (Lea)	Shell short, broad and ovate, anterior end rounded; posterior gradually tapering; anterior muscle scar deep and oval, posterior semilunar	Cold water lakes	Arunachal Pradesh, Assam, Mizoram, Uttar Pradesh, West Bengal

(continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Parreysia (Parreysia) smaragdites</i> (Benson)	Shell with narrow anterior broad posterior; lunule prominent	Brahmaputra river basin	Assam
<i>Parreysia (Parreysia) triembolus</i> (Benson)	Shell thick with large teeth; posterior end tapering	Rivers, Narmada river basin	Assam, Uttar Pradesh, West Bengal
<i>Parreysia (Radiatula) anderssoniana</i> (Nevill)	Shell smaller, thin, umbon indistinct, not at all raised; sculpture strong on umbonal region, pallial line prominent	River bed	Assam, West Bengal
<i>Parreysia (Radiatula) bonneaudi</i> (Eydoux)	Sculpture only on umbonal region and with vertical marking on the rest of the surface	River bed	Andhra Pradesh, Assam, Manipur
<i>Parreysia (Radiatula) caerulea</i> (Lea) Subsp. <i>gaudichaudi</i> (Eydoux)	Shell elongate, variable in shape, sculpture restricted to the upper half of the valves in the adult, posterior umbonal carina very distinct	River bed, Gangetic delta	Andhra Pradesh, Assam, Jharkhand, Meghalaya, Mizoram, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal
<i>Parreysia (Radiatula) cylindrica</i> (Ammandale and Prashad)	Shell thick, dorsal margin straight and anterior margin broadly rounded, umbonal region sculptured with corrugated ridges	River bed	Maharashtra Endemic
<i>Parreysia (Radiatula) involuta</i> (Benson)	Shell compressed in front, swollen in the umbonal region with a few longitudinal corrugations, beaks incurved	River bed	Assam
<i>Parreysia (Radiatula) khadakvaslaensis</i> (Ray)	Shell elongated more inflated, posterior end pointed; sculpture appears to be a little more pronounced	River bed	Maharashtra: Pune
<i>Parreysia (Radiatula) lima</i> (Simpson)	Shell small with broad posterior end; umbo much anterior, sculpture more prominent on umbona region, zigzag and transverse lines prominent on posterior side, finer on anterior	River bed	Assam, Sikkim, and West Bengal
<i>Parreysia (Radiatula) nuttalliana</i> (Lea)	Shell small, smooth, devoid of any sculpture; umbo prominent, olive green in colour	River bed	Assam: Cachar
<i>Parreysia (Radiatula) occata</i> (Lea)	Shell rhomboidal, narrow, sculptured with granular ridges throughout the surface	Gangetic delta, and its tributaries, river bed	Assam, Madhya Pradesh, Manipur, Meghalaya, Rajasthan, Uttar Pradesh, West Bengal

<i>Parreyisia (Radiatula) olivaria</i> (Lea)	Shell small, thin, devoid of any sculpture; umbon prominent and middle; olive green colour	River bed	Assam, Meghalaya, Uttar Pradesh, West Bengal
<i>Parreyisia (Radiatula) pachysoma</i> (Benson)	Shell more elongate, inflated; umbon pronounced, with much stronger hinge, radial sculpture absent.	River bed	Andhra Pradesh, Assam, Meghalaya, Orissa, West Bengal
<i>Parreyisia (Radiatula) shurtleffiana</i> (Lea)	Shell having some typical sculpture on umbonal region and on anterior slope.	River bed	Bihar, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh
<i>Parreyisia (Radiatula) theobaldi</i> (Preston)	Shell broad and elongate; sculpture absent on dorsal surface	River bed	Assam, Manipur
<i>Trapezoides exolevens exolevens</i> (Gould)	Shell thin, trapezoidal, brownish yellow, compressed, umbones depressed, anterior end narrow, short, posterior side dilated, posterior wing not distinct	River bed	Assam, Manipur, Mizoram, Nagaland
<i>Pseudomulleria dalyi</i> (E.A. Smith)	Shell irregularly quadrate, periostracum deep brown or blackish brown, nacre mixture of white, greenish, bluish, olive and pinkish, margin olive brown	Streams	Western Ghats (Karnataka and Maharashtra)
<i>Neosolen aquaedulcoris</i> (Ghosh)	Shell thin, elongated; anterior end truncated, posterior end rounded, one small long cardinal tooth in the right valve, anterior adductor scar long, triangular, posterior small, rounded	Lakes of tidal influence and Gangetic delta	Orissa: Chilka Lake, West Bengal: Sundarbans
<i>Tanysiphon rivalis</i> (Benson)	Shell small, thin elongately ovate with greenish periostracum; umbo anterior; ligament short external; hinge with three cardinal teeth in each valve; anterior twp smaller and posterior flattened	Gangetic delta	West Bengal: River Ganges
<i>Novaculina gangetica</i> (Benson)	Shell oblong with truncated extremities, periostracum olivaceous	Rivers Ganges	West Bengal: River Ganges
<i>Corbicula amandalei</i> (Prashad)	Umbon central, prominent, greatly inflated and curved forwards, hinge very feeble	Back water of Kerala	Known from type locality only Kerala: Varkala
<i>Corbicula assamensis</i> (Prashad)	Shell thin, ovate, anterior short, rounded, posterior broad and truncate, umbones slightly marked, striae not deep, shining light yellow colour	Brahmaputra river bed	Assam
<i>Corbicula bensoni</i> (Deshayes)	Shell subtriangular, transversely ovate, thin, striae fine and microscopic	Gangetic river belt	Bihar: Bhagalpur; West Bengal: Kolkata, Hugli, Nadia (continued)

Table 11.4 (continued)

Name	Key character for identification	Habitat	Distribution
<i>Corbicula cashmiriensis</i> (Deshayes)	Ventral margin evenly arched, ending posteriorly in a distinct truncated beak in full-grown specimens; sculptured with prominent-raised ribs; hinge broad and strongly developed	River belt	Kashmir Endemic
<i>Corbicula krishnaea</i> (Ray)	Shell small, thin, striae regular and distinct, escutcheon bearing distinct ribs	Krishna river	Known from type locality only Krishna river, near Sangli, Pune and Maharashtra
<i>Corbicula peninsularis</i> (Prashad)	Shell ovately triangular, dorsal margin convex, posteriorly down into a regular beaklike structure, pallial line wide	Estuarine water with tidal influence	Known from type locality Bombay
<i>Corbicula striatella</i> (Deshayes)	Shell thick, sculpture strong, hinge with prominent teeth	River	Throughout India
<i>Batissa inflata</i> (Prime)	Shell oblique; umbo more anteriorly placed, anterior margin short and more sloping, posterior margin curved	Creeks of tidal influence	Andaman and Nicobar Islands
<i>Batissa similis</i> (Prime)	Umbo slightly anterior, anterior margin short and less sloping, posterior margin curved and biangulate	Creeks of tidal influence	Andaman and Nicobar Islands
<i>Polymesoda (Geloina) bengalensis</i> (Lamarek)	Shell subtriangular, tumid, solid, thick, unequilateral; periostracum blackish brown, coarsely striated	Estuarine water with low salinity	Orissa: Mahanadi estuary; West Bengal: Gangetic delta; Nicobar Island
<i>Polymesoda (Geloina) erosa</i> (Solander)	Shell large, subtriangular, unequilateral, solid, periostracum thin yellowish or thick and brownish	Back waters and estuaries	Andhra Pradesh: Krishna; Andaman and Nicobar Islands: Lawrence and Havlock Islands, Car Nicobar, Kondul, Trinket Island, Goa, Maharashtra
<i>Villorita cornucopia</i> (Prashad)	Shell high and narrow, umbones broad, high and recurved umbonal region with coarse concentric ridges, ligament very long and thick. Anterolateral short with a groove	Found in backwater of South India, occasionally in freshwater	Kerala back water
<i>Pisidium (Pisidium) casertanum</i> (Poli)	Shell ovate, subcordate, strong, somewhat tumid, feeble but distinct concentric striae, ligament pit long and deep extending to about the middle of the hinge plate; juveniles yellowish, full grown shells deep yellow with darker olive bands	Upper cretaceous Mud dwellers Hill streams	Kashmir

<i>Pisidium (Afropisidium) clarkeanum</i> (G. and H. Nevill)	Shell inflated, moderately thick, umbo projecting greatly over the hinge, surface pale yellow with close set striae	Ponds, lakes, wetlands, rivers	Andhra Pradesh: Cuddapah; Bihar: Harrapur, Bhagalpur; Jharkhand, Maharashtra: Mumbai; Manipur: Chandel; Tamil Nadu: Nilgiris (7,400 ft); Uttar Pradesh: Roorkee; West Bengal: Kolkata, 24 Parganas (South)
<i>Pisidium (Afropisidium) ellisi</i> (Dance)	Shell semitransparent, thin, dorsal margin sloping steeply on the posterior side, ventral margin gently curved, periostracum yellowish brown	Hill streams	Sikkim
<i>Pisidium (Afropisidium) nevilleianum</i> (Theobald)	Shell thin, large, trigonal and porcellaneous, striae all over umbones prominent and round	Narmada river, Gangetic river	Madhya Pradesh: Narmada River; Uttar Pradesh: Roorkee
<i>Pisidium (Europisidium) mitchelli</i> (Prashad)	Shell subtrigonal, large very tumid, thin and fragile, distinct closed-set striae all over, deep horn colour, shining	Marshall Lake an altitude of 4,500 ft.	Kashmir
<i>Pisidium (Odhnepisidium) atkinsonianum</i> (Theobald)	Shell medium, orbiculate ovate, dorsal margin slightly sloping with well-marked shoulder on the posterior slope; anterior margin sub-truncate	Jongla Lakes at an altitude of ~ 10,000 ft, large lakes	Manipur: Senapati; Meghalaya: Khasi Hill (East), Jaintia Hills; Sikkim, West Bengal: Darjeeling
<i>Pisidium (Odhnepisidium) kuiperi</i> (Dance)	Shell thin, semitransparent; umbones broad, central, not prominent; dorsal margin with a steeper slope posteriorly; ventral margin almost straight; sculpture with fine striae	Mud dwellers	Sikkim
<i>Sphaerium austeni</i> (Prashad)	Shell thick, elongately ovate, subequilateral, opaque, swollen; umbone prominent	Hill streams	Manipur, Nagaland
<i>Sphaerium indicum</i> (Deshayes)	Shell small, ovately rhomboid, unequilateral with fine concentric striae; right valve with a well-developed cardinal	Plains and hill streams	Throughout India
<i>Sphaerium kashmirensis</i> (Prashad)	Shell subquad rare, subequilateral, swollen, umbone prominent, incurved and tumid, sculptured with well-marked closely situated concentric striae	Walur Laker at an altitude of 5,180 ft and 0.5–10 m depth.	Kashmir

evolution (Prashad 1928). Some species such as *Sulcospira huegeli* show a disjunct distribution, being found in the central and southern Western Ghats and in northeastern Indian states (Subba Rao 1989).

Recently, two new species of freshwater molluscs belonging to the genus *Paracostoma* have been described from the Western Ghats (Köhler and Glaubrecht 2007). The genus *Paracostoma* is monophyletic and is restricted to few streams in the central Western Ghats and nested within a clade of Southeast Asian taxa composed of *Brotia* and *Adamietta*. These authors argue that the “origins of the Indian biota are more complex and diversethan assumed under the standard Mesozoic vicariance model.” Hence, zoogeographically, the Western Ghats freshwater mollusks offer a great opportunity for biologists.

A few sporadic studies were carried out in northern Western Ghats, mainly from Pune by Tonapi (1971), and Tonapi and Mulherker (1963). Recently, Patil and Talmale (2005) reviewed land and freshwater molluscs of Maharashtra State and listed 72 species and varieties. Most of these studies were concentrated on distributional aspects and no indepth study on ecology. In India very scant attention has been paid to the biology and ecology of molluscs and in particular of bivalves (Subba Rao 1989), and therefore the ecological needs of a great majority of the Indian freshwater molluscs are not known. Apart from Volume IV of Fauna of British India by Preston (1915), there are only two other books that deal with Indian freshwater molluscs; these are Subba Rao (1989) and Ramakrishna and Dey (2007). The book on *Indian Freshwater Molluscs* gave updated information on the distributions with maps (Ramakrishna and Dey 2007).

Freshwater molluscs of the Western Ghats region are better known than in other parts of India or other species-rich areas within South and Southeast Asia. This assessment is based on the scattered published work, mostly coming from the northern Western Ghats and our own field studies. Still, a large amount of work needs to be done, examining the ecosystem services these species provide, the impact of aquatic-invasive plants, the distribution patterns, population status and

dynamics of molluscs, and their species-specific threats. Most of the data deficient species identified here have not been collected since their description (often in nineteenth or early twentieth century) or have very meagre collection details. In many cases, the description of the species is based on either single specimen or very few specimens, and no natural history or ecology is detailed. It is important to revisit the type localities of these species to get adequate information on ecology and threats, to see if they are still present or have already become extinct, and in many cases to confirm their taxonomic status (Budha et al. 2011). Here we consolidate our study on the basis of available literature and personal findings from different surveys in Tables 11.4 and 11.5.

Endemism

A detailed study on endemism of freshwater molluscs available reveals that 47 species are endemic from India out of the 202 listed of which 33 are gastropods and 14 are bivalves (Fig. 11.1a, b). Two species are endemic from Andhra Pradesh, one from Punjab, seven species from Assam, three from Manipur, one from Meghalaya, two from Mizoram, 13 from West Bengal, two from Tamil Nadu, six from Maharashtra, three from Andaman and Nicobar Islands, five from Kerala Backwater and three from Jammu and Kashmir are endemic species.

Endemism from North Himalayan Region

Mollusca are originated from various invasion of freshwater fauna into the Himalayas since the Pliocene period (low-middle mountain fauna). The transitional zone of Nepal and the Himalayas has mixed freshwater faunas, from Oriental and Palaearctic regions with numerous hitherto neglected endemics, such as *Tricula* species and *Pisidium* spp. They are originated from several so-called inner valleys of the Himalayas which were seasonal lakes and wetlands during Pleistocene glaciations (Nesemann et al. 2007).

Table 11.5 Statewise distribution of freshwater Mollusca of India

Sl. No.	States	Families	Genera	Species	%
1	Andaman and Nicobar Islands	10	20	51	25.24
2	West Bengal	14	21	65	32.17
3	Bihar	13	19	55	27.22
4	Orissa	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
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

Endemism from Northeastern Himalayan Region

Northeastern Himalayan region shows a high degree of endemism especially within bivalves comparative to the other parts of India. Consistency for the long period of endemism is probably due to the geographical barrier and selective habitat by the species. Among the 64 bivalve species from India, 14 species are endemic from this region i.e. about 21 %, among gastropods it is quite less i.e. near about 6 %, and among gastropods eight species are endemic from this region. Some species mentioned known from type locality also is not reckoned here as endemic because further information on the availability of the particular species is not yet ascertained.

Endemism from Western Ghats

Nearly 212 species of freshwater molluscs have been reported from India (Subba Rao 1989). Of these, only 60 species were recorded from the

Western Ghats hot spot by Shivaramakrishnan et al. (1998); however, it is likely that many species were missed. This is substantiated by recent records of species such as *Arsidopsis footi* and *Neritina reticulata*, two species of *Paracrostoma* and five new species of *Cremnochonchus* from the Western Ghats. This region is also home to some of the most important zoogeographical and Gondwanaland relict species, such as *Pseudomulleria dalyii* (Etheridae), a cemented freshwater pearl species, and three species of *Cremnochonchus* (Littorinidae) found in the spray zones of waterfalls at high elevations in the Western Ghats. With very few ecological studies having been carried out on these unique and cryptic freshwater taxa in India, it is critical to work out their habitat requirements and distributions for their suitable conservation strategies to be developed.

In Western Ghats, two species of Neritidae (*Neritina pulligera* and *Neritina violacea*), three species from Corbiculidae (*Villorita corbiculoides*, *V. cornucopia* and *V. cyprinoides*) and two species from Iravadiidae (*Iravadia funereal* and *I. ornata*) are found exclusively in brackish water.

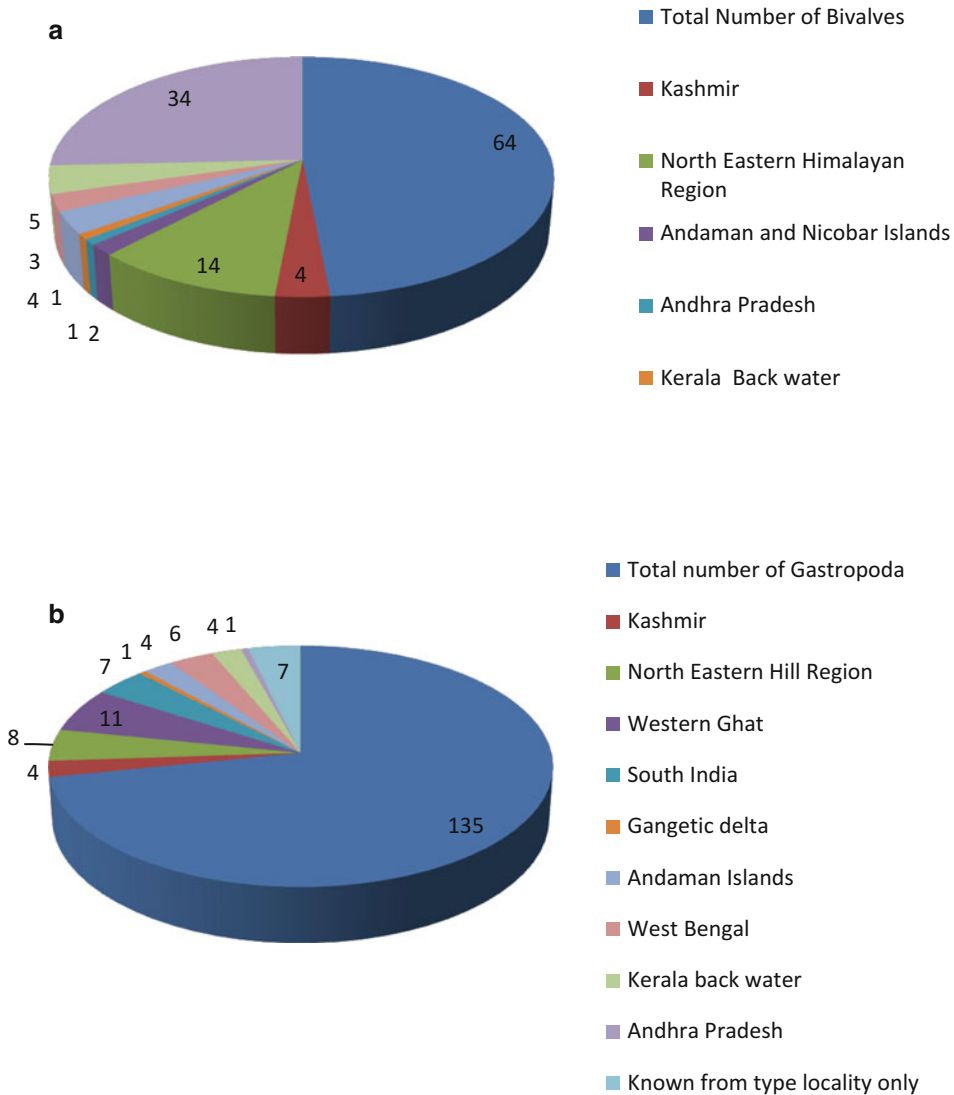


Fig. 11.1 (a, b) Distribution of endemic freshwater mollusks of India

The genus *Villorita* (Corbiculidae) is confined to the backwaters and estuaries of the west coast. These species cannot withstand high salinity levels and are usually found in the upper regions of the backwaters where the salinity is below 15 %. Here they burrow into the soil to escape unfavourable condition during summer when salinity increases above 15 % (Cherian 1968, Aravind et al. 2010).

A total of 77 species of freshwater molluscs is studied of which 52 gastropods (12 families and

23 genera) and 25 bivalve species (five families and eight genera) of which 28 species are endemic from this region (Aravind et al. 2010).

Conservation

Molluscs play essential roles in almost every known ecosystem. Many molluscs are links in food chains, the pathways between green plants and the animals that are food for humans and

other animals. Molluscs show a great specialization of ecological niches in freshwater environments, making them more vulnerable to modifications in their environment (Bouchet 1992; Lydeard et al. 2004). Freshwater environments are some of the most fragile and highly threatened ecosystems in the world. Consequently, molluscs in the freshwater systems have suffered a severe decline in the diversity, distribution and abundance due to human-induced alteration of habitats, pollution, siltation, deforestation, poor agricultural practices, the destruction of riparian zones and invasion by introduced species (Biggins et al. 1995; Pimm et al. 1995). In India, because of urbanization to accommodate more and more people by destructing natural habitat like lakes, pools, ditches, small water bodies, making dams, etc., lead to extinction of species from that area within a very short time span. Speciation is a natural procedure which is controlled by natural selection, but loss of speciation by human being is a great loss of biodiversity with unasserted valuable assets. Agricultural and urban water pollution, over harvesting, dams, urban development and mining are the major threats to freshwater molluscs today.

Conservation Strategies and Implementation of Key Models

1. Conservation strategies for freshwater mollusca should emphasize establish biological monitoring programmes at the local level to aid in the assessment of the current status of regional molluscan diversity. Monitoring programmes are multipurpose management tools which will provide for:
 - (a) Data on the biotic and abiotic characteristic of the environment which identify regions of greatest molluscan diversity
 - (b) Immediate warning of nonacceptable impacts of human activities and their waste products on the environment
 - (c) A long-term database to evaluate and forecast natural changes and impacts of human activities
 - (d) Identification of endangered habitats and threatened species
 - (e) Identification of stocks of molluscs of potential use in fisheries, the shell trade, and biomedical research
2. Establish baseline from distributional information available in systematic works and unpublished information for mapping habitat and at species level.

Conservation Status of Freshwater Mollusca in India

According to a report of IUCN, seven species (12 %) are assessed as threatened which are *Cremnochonchus syhadrensis*, *C. carrinatus*, *Arcidopsis footei* and *Pseudomulleria dalyi* are assessed as Endangered and *Cremnochonchus conicus*, *Parreysia khadakvasiensis* and *Scaphula nagarjunai* are assessed as vulnerable. The majority (88 %) are assessed as least concern (Aravind et al. 2010). However, much on the conservation status is not adequately known in the absence of baseline data on their distribution and population with respect to time and space and therefore, more information is required on this.

Role of Govt. Organizations Towards Freshwater Mollusca Conservation and Management

The Zoological Survey of India, since its inception, has in its custody and care collections of the natural history museum, in Calcutta, India, that are over 200 years old, as well as subsequent collections made by scientists and staff of ZSI since 1916. As per Section 39 of the Biological Diversity Act 2002 of India, ZSI is notified as *Designated National Repository for Zoological Collections* (NZC) of India. The NZC housed at ZSI now contains more than 3,000,000 authentically identified specimens comprising over 90,000 known species of animals. The NZC, the *national heritage* of the country, was acquired from the museum of the Asiatic Society of Bengal,

the zoological section of the Indian Museum, and collections through various surveys till now which started in the early part of nineteenth century. Many distinguished naturalists such as John McClelland, Edward Blyth, W. Blanford, H. Blanford, T. Cantor, Francis Day, H.H. Godwin Austen, T. Hardwicke, B. Hodgson, G. Nevill, H. Nevill, F. Stoliczka, W.M. Sykes, W. Theobald, S.R. Tickell, J. Anderson and H. Wood-Mason significantly contributed in documenting the fauna of Indian subcontinent which are part of the NZC. This work mainly based on the available literature on freshwater Mollusca from India, specimens present in the NZC of ZSI and specimens received in Mollusca section of ZSI from different parts of the country for identification. The authors also have personally collected and examined large number of specimens through field surveys conducted by the Mollusca section of ZSI. ZSI cannot alone able to successfully conserve the national biodiversity with limited strength. Therefore, universities, colleges, schools and nongovernment organizations require capacity building on further studies on molluscan taxonomy, diversity and conservation in India.

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