ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 04, pp.29169-29176, April, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

DIVERSITY OF FRESHWATER MOLLUSC IN MAGURI BEEL- A FLOODPLAIN WETLAND OF TINSUKIA DISTRICT IN ASSAM, INDIA

Devid Kardong, Munmi Puzari and *Jyotish Sonowal

Department of Life Sciences, Dibrugarh University, Dibrugarh, Assam, Pin: 786004, India

ARTICLE INFO

Article History:
Received 04th January, 2016
Received in revised form
10th February, 2016
Accepted 07th March, 2016
Published online 26th April, 2016

Key words:
Freshwater mollusc,
Conservation,
Diversity,
Local assessment,
Threatened groups.

ABSTRACT

Freshwater molluscs have great environmental significance but seem to receive less attention of biologists in the North-eastern region of India. The diversity and distribution pattern of freshwater mollusc population in Maguri 'beel' *(Assamese: Lake)* of upper Brahmaputra basin in Assam, India was assessed for two consecutive years (2014–15). A total of 26 species belonging to nine families were recorded. The families Viviparidae followed by Thiaridae and Unionidae were found to be the dominant families whereas representatives of the families Pleuroceridae and Ampullariidae were rare. Analysis of diversity indices indicated a diverse mollusc population dominated by few species, heterogeneously distributed in the study area. The assessment on the conservation status of the mollusc population revealed most of the recorded species to be in the least concerned (LC) category with unknown (UN) population trends as per the IUCN Red list status (3.1). However five species were dominant (D), three frequent (F), 16 infrequent (IF) and two rare (R) at the local context. The record of *Sphaerium austeni* (Prashad, 1921) which is found to be a near threatened species at global context is a key example in the assessment of local status. While overharvesting and predation pressure on fish and mollusc population are identified as the key threats to the wetland.

Citation: Devid Kardong, Munmi Puzari and Jyotish Sonowal, S. 2016. "Diversity of freshwater Mollusc in Maguri beel- a floodplain Wetland of Tinsukia District in Assam, India", *International Journal of Current Research*, 8, (04), 29169-29176.

INTRODUCTION

Freshwater molluscs are a diverse group comprising about 4% of whole freshwater taxa, and are ranked fifth in number of species. They are distributed throughout the freshwater bodies of the globe except Antarctica (Graf and Cummings, 2007; Strong et al., 2008). However, they are among the most threatened group of freshwater animals (Balian *et al.*, 2008).
Molluscs play a significant role in the ecosystem (Budha *et al.*, 2010) as they form a vital part in the food chain in it. Likewise, freshwater bivalves are efficient filter feeders and can remove organic pollutants from natural ecosystems. But, at the same time, most of them are highly sensitive to pesticide pollutants and anthropogenic pressure on the aquatic ecosystems and so make good sentinel organisms to describe biodiversity and the health of an aquatic ecosystem (Sicuro, 2015; Bogan, 2008). There has been some attempt to exploit the beneficial uses of freshwater molluscs during last few decades. In recent years, for instance, the integration of fish farming with the mollusc culture has been initiated to improve the commercial production of fish (Sicuro, 2015).

****Corresponding author: Jyotish Sonowal***
Department of Life Sciences, Dibrugarh University, Dibrugarh, Assam, Pin: 786004, India

Freshwater mussels are also reared for human consumption as well as pearl production activities (FAO, 1986 and Chakraborty *et al.*, 2010). A sizable number of literatures are available globally on diversity, distribution and taxonomy of freshwater molluscs. Köhler *et al.* (2012) recorded 325 gastropod species from 20 families and 116 bivalve species from ten families from the Indo-Burma region. However, most of the information on the status of freshwater molluscs from Indo-Burma region is based on the studies in the Mekong river basin covering the nations like Vietnam, Laos, Cambodia, Thailand, Burma, etc.

Barring a few baseline works reported from the Barak valley, no comprehensive study has been conducted on the status and distribution of freshwater molluscs on the Brahmaputra basin of the Northeast (NE) India. This is the part of Eastern Himalayan Biodiversity Hot Spot region where information on the distribution, taxonomy and biology of molluscs is severely limited (Kumar and Vyas, 2012; Ramesha *et al.,* 2013; Buddha *et al.,* 2010). In India, pioneering works on diversity, distribution and taxonomy of freshwater molluscs was carried out by Preston (1915), Annandale (1918), Prashad (1920, 1928) and recently reviewed by Subba Rao (1989) and Ramakrishna & Dey (2007).

MATERIALS AND METHODS

Study area: The Maguri beel, covering an area of 6.56 sq. km. and located 27.3432^0 N and 95.2343^0 E (Fig. 1) is one of the major wetlands of the upper Brahmaputra basin in the Tinsukia district of Assam. It is a part of the Dibru Saikhowa Important Bird Area (IBA IN-AS-13) lying just at the edge of Dibru Saikhowa National Park and Biosphere Reserve (DSNPBR). The DSNPBR with the records of about 385 bird species (both resident and migratory) also harbours a population of 108 fish species as major aquatic bio-resources (Chaudhury 1997, 2002). This highly productive wetland, which opens into the River Brahmaputra, is fed by numerous water channels from the upstream surroundings.

Sampling (collection, preservation and identification): Random sampling was conducted in 14 different stations of Maguri beel per year for two consecutive years (2014–15) using quadrate method (1 m^2 size). At least 10 samplings were taken at each station. The average depth of the collection sites were maintained at around 1 m or less as most of the species except few large bivalves were localized in shallow water. Large specimens were handpicked and the smaller ones were collected from the bottom substrata by using a metal sieve of mesh size 1 mm^2. Specimens from each quadrate were then washed, representatives of different species counted and collected in clean poly packs. The representatives were brought to the laboratory and preserved in 80% ethanol for future references. Identification of the samples was done according to Subba Rao (1989), Ramakrishnan & Dey (2007) and the available updated literatures from IUCN. The identification was further authenticated with the help of Zoological Survey of India (ZSI), Kolkata.

Statistical analysis: Statistical analysis was done for assessment of species richness and diversity status of the studied area. Likewise, all nonparametric asymptotic species richness estimations are calculated using bias corrected formulas in EstimateS software (Robert K. Colwell, 2013). The calculation of different diversity indices such as Simpson (1 – D), Shannon (H) and Evenness index [exp (H)/S] that reflects the diversity and even occurrence of species within a community, Renyi entropy / Hill Number (q = 0, 1, 2) to find out the "Effective Number of species" in different stations were done with PAST 3. SHE analysis was carried out to examine the relationship between Species Richness (S), the Shannon-Wiener diversity index (H) and evenness (E) amongst the samples. It is an approach to look into the contribution of species number and its equitability to changes in diversity. By convention, SHE analysis follows the way how these parameters changes with increasing sampling effort. Sample based rarefaction curve was plotted from samples taken randomly to estimate the projected species richness. Neighbour joining cluster was constructed using the species present in different site and their abundance to find out the biotic interaction between species. Statistical analysis was carried out taking 95% confidence limits.

RESULTS

Species Composition: In the present survey, altogether 26 species belonging to nine families from five orders representing two classes have been recorded and their taxonomic positions are listed in Table 1 and 2 respectively. Out of the nine families recorded, six were from class gastropoda and three from bivalvia indicating a gastropod dominated mollusc population of the wetland.

Table 1. List of recorded freshwater mollusc from Maguri beel

No.	Recorded Species	Sampling Stations													
		A	B	C	D	E	F	G	H	I	J	K	L	M	N
1.	*P. virens*	-	-	-	-	+	-	-	-	-	-	-	-	-	-
2.	*P. globosa*	-	-	-	-	-	-	-	-	-	+	-	-	-	+
3.	*P. pachysoma*	-	-	-	+	-	-	-	-	+	-	-	-	-	+
4.	*I. dissimilis*	-	-	+	-	+	-	-	-	+	-	-	-	-	-
5.	*A. microchaetophora*	-	+	-	-	+	-	-	-	-	-	+	-	-	-
6.	*L. corrianus*	-	+	-	-	-	-	-	+	-	-	+	-	-	-
7.	*B. costula*	-	-	-	+	+	-	-	-	-	-	-	+	-	-
8.	*L. marginalis*	+	-	-	-	-	-	-	-	+	-	+	-	-	-
9.	*P. smaragdites*	+	-	-	+	-	-	-	-	+	-	-	-	-	+
10.	*A. oxytropis*	-	+	-	-	+	-	-	-	-	-	+	-	-	-
11.	*I. umbilicalis*	+	+	-	-	+	-	+	-	+	-	-	-	-	-
12.	*M. crassa*	+	-	+	-	-	-	+	-	-	-	+	-	+	-
13.	*P. corbis*	+	-	-	-	-	-	-	-	+	-	-	-	-	+
14.	*L. acuminata*	+	-	-	+	-	-	+	-	-	-	-	-	-	-
15.	*S. austeni*	-	-	-	-	+	-	-	+	-	-	+	-	-	+
16.	*P. scabra*	+	+	-	+	+	-	-	-	-	-	-	-	-	+
17.	*I. exustus*	+	+	-	-	+	-	-	+	-	+	+	-	+	-
18.	*P. lima*	+	-	-	+	+	-	-	-	+	-	-	+	-	+
19.	*C. striatella*	+	-	-	+	-	-	-	-	-	+	-	+	+	+
20.	*Pisidium* sp.	+	-	+	-	+	-	+	-	-	+	+	-	+	-
21.	*S. indicum*	+	-	-	-	-	+	-	-	+	-	+	-	+	-
22.	*C. assamensis*	+	+	+	-	-	+	+	+	-	+	+	+	+	-
23.	*T. granifera*	-	+	+	-	+	+	+	+	-	+	+	+	+	-
24.	*B. bengalensis*	+	+	+	+	+	+	-	+	+	+	+	+	-	+
25.	*M. tuberculata*	+	+	+	+	+	+	+	+	-	-	+	+	+	+
26.	*T. lineata*	-	+	+	+	+	+	+	+	+	+	-	+	+	-

Table 2. Systematic position and taxonomic keys of freshwater mollusc from Maguri beel

Class	Order	Family	Genus & species	Taxonomic Keys Taxonomic keys
Gastropoda	Architaenioglossa	Viviparidae	*Bellamya bengalensis* (Lamarck,1822)	Shell thin, gradually increasing whorls, shallow sutures, rather straight sides.
			form – *typica* (Lamarck)	Spire & body whorl of almost equal height, less rounded, with rather straight sides, aperture sub circular with narrow black margin.
			form – *annandalei* (Kobelt, 1908)	Shell thinner & apex more acute than *typica*, whorls gradually increasing, sutures shallow.
			Mekongia crassa (Benson, 1836)	Shell olive green, globose with fine wavy lines, spire small, blunt, columella and outer lip arched, umbilicus perforate.
			Idiopoma dissimilis (Müller, 1774)	Shell small, suture impressed, aperture rim often black, operculum thick.
			Angulyagra microchaetophora (Annandale, 1921)	Shell thin, imperforate, sharply acuminate, blunt peripheral ridge on last body whorl, spiral whorls with two fine spiral ridges.
			Angulyagra oxytropis (Benson, 1836)	Shell large, spiral whorls with two smooth prominent spiral ridges, outer lip thin, regularly arched.
		Ampullaridae	*Pila globosa* (Swainson, 1822)	Shell globose, spacious, upper surface of whorls obliquely flattened, suture not deep, spire depressed.
			Pila virens (Lamarck, 1822)	Shell large, globose, imperforate or sub perforate, body whorl highly inflated and shouldered above, spire short, sutures deep, distinctly canaliculated, aperture ovate.
	Sorbeoconcha	Thiaridae	*Plotia scabra* (Müller, 1774)	Shell elongate, spire high, with vertical ribs bearing prominent spines directed outward, surface with rough spiral striations, strong ridges near umbilicus.
			Melanoides tuberculata (Müller, 1774)	Shell with high spire, moderately large body whorl, dark brown dots, sculptured conspicuously with vertical ribs.
			Tarebia granifera (Lamarck, 1822)	Shell elongate, conical, sculptured with distinct spiral rows of nodules, spire sharp with flat whorls, height of body whorl more than half of the shell.
			Tarebia lineata (Gray, 1828)	Similar to *T. granifera* but rows of nodules are less distinct, dark spiral lines, apex acute.
		Pachychilidae	*Brotia costula* (Brandt, 1974)	Shell elongate, 12-14 whorls, regularly increasing, sculpture with spiral ridges, prominent axial ribs often with spires.
	Hygrophila	Lymnaeidae	*Lymnaea acuminata* Lamarck, 1822	Shell thin, ovate, spire short, acuminate, body whorl inflated, little angular above with large aperture.
			form – *gracilor* Martens, 1881	Shell linear with a long narrow spire, colour of the shell varies between grayish to light pink.
			form - *patula* (Troschel, 1837)	Shell narrower than typical form, spire large, anterior extremity of aperture tapering.
		Planorbidae	*Intha umbilicalis* (Benson, 1836)	Shell small, depressed, narrowly coiled, umbilicate, whorls 3, rapidly increasing in width, body convex above and flattened below.
			Indoplanorbis exustus (Deshayes, 1834)	Shell large, thick, discoidal, sinistral, rounded at periphery, aperture ear-shaped, suture deeply impressed, body whorl near aperture is slightly larger with prominent striations.
Bivalvia	Unionoida	Unionidae	*Lamellidens marginalis* (Lamarck, 1819)	Shell oblong ovate, periostracum blackish brown with light brown border along ventral margin, posterior side broad, rounded, angular, narrow wing, ventral margin slightly contracted in middle.
			Lamellidens corrianus (Lea, 1834)	Shell elongate, elliptical, umbone slightly inflated, periostracum smooth, dark brown with yellowish band, dorsal margin almost straight and long.
			Parreysia corbis (Hanley, 1856)	Shell oval, inequilateral, thin, bluish green with yellow bands, shell smooth except at the umbones with longitudinally divergent slender corrugations.
			Parreysia smaragdites (Benson, 1862)	Shell green interspersed with lemon yellow in the middle, beaks submedian and greatly deflected forwards with deep cavities, lunule marked.
			Parreysia lima (Simpson, 1900)	Shell small, greenish, broad posterior end, umbo much anteriorly placed, sculpture more pronounced on the umbonal region, typical zigzag transverse lines prominent on the posterior side.
			Parreysia pachysoma (Benson, 1862)	Shell elongate, inflated, umbo pronounced, with much stronger hinge, radial sculpture absent.
	Veneroida	Cyrenidae	*Corbicula assamensis* Prashad, 1928	Shell ovate or triangularly ovate, dorsal margin regularly arched convex, anterior side short and rounded, posterior broad and truncate, striae regular concentric, distinct, but not deep
			Corbicula striatella Deshayes, 1854	Shell large, ovate, dorsal margin arched, umbones prominent, striae regular, concentric, raised into ridges, pallial line with trace of sinus.
		Sphaeriidae	*Pisidium sp.* Pfeiffer, 1821	Shell small, ovoid to orbicular, equivalve, inequilateral, posterior side short and broad than anterior, concentrically striate, olive horny periostracum, umbones prominent, beaks posterior, lateral teeth double in right valve, single in left valve, cardinals two in left valve, one in right valve.
			Sphaerium indicum Deshayes, 1854	Shell small, rhomboid, inequilateral with finely concentric striae, anterior end rounded, posterior end obtuse truncate, right valve with well developed cardinal, one laterals well developed and less curved.
			Sphaerium austeni Prashad, 1921	Shell thick, ovate, sub-equilateral, opaque, umbones prominent, elevated, incurved, anterior margin small and broadly rounded, posterior margin almost straight and truncated, ventral margin convex, sculpture with concentric striae in adult, hinge with one lateral and two cardinals, thin and lamellar in left valve; two laterals, lamellar, and two cardinals, anterior large and triangular, posterior small and rounded in right valve.

Among gastopoda, Viviparidae (5 sp.) and Thiaridae (4 sp.) were the dominant families while Ampullariidae (2 sp.), Pachychilidae (1 sp.), Lymnaeidae (1 sp.) and Planorbidae (2 sp.) were found to be infrequent families. The species *Tarebia granifera* (Lamarck, 1816); *Tarebia lineata* (Gray, 1828); *Melanoides tuberculata* (Müller, 1774), *Bellamya bengalensis* (Lamarck, 1882) of class gastropoda and *Corbicula assamensis* Prashad, 1928 from class bivalvia were the abundant species with highest number of individuals encountered in almost all stations. The *Pila virens* (Lamarck, 1822) and *Pila globosa* (Swainson, 1822) represented as singleton and doubleton species respectively.

The multiple forms of certain species of families Viviparidae and Planorbidae have also been recorded (Table 2). For instance, the *B. bengalensis* with its forms *typica* (Lamarck) and *annandalei* (Kobelt, 1908) and *Lymnaea acuminata* with its forms *patula* (Troschel, 1837) and *gracilior* (Martens, 1881) were commonly encountered in the wetland. Out of three bivalve families, Unionidae with six species was recorded as the dominant family over Cyrenidae and Sphaeriidae in terms of number of the representative species. On the other hand, representatives from families Cyrenidae were found to be more ubiquitous as compared to that of the Unionidae and Sphaeriidae (Table 1).

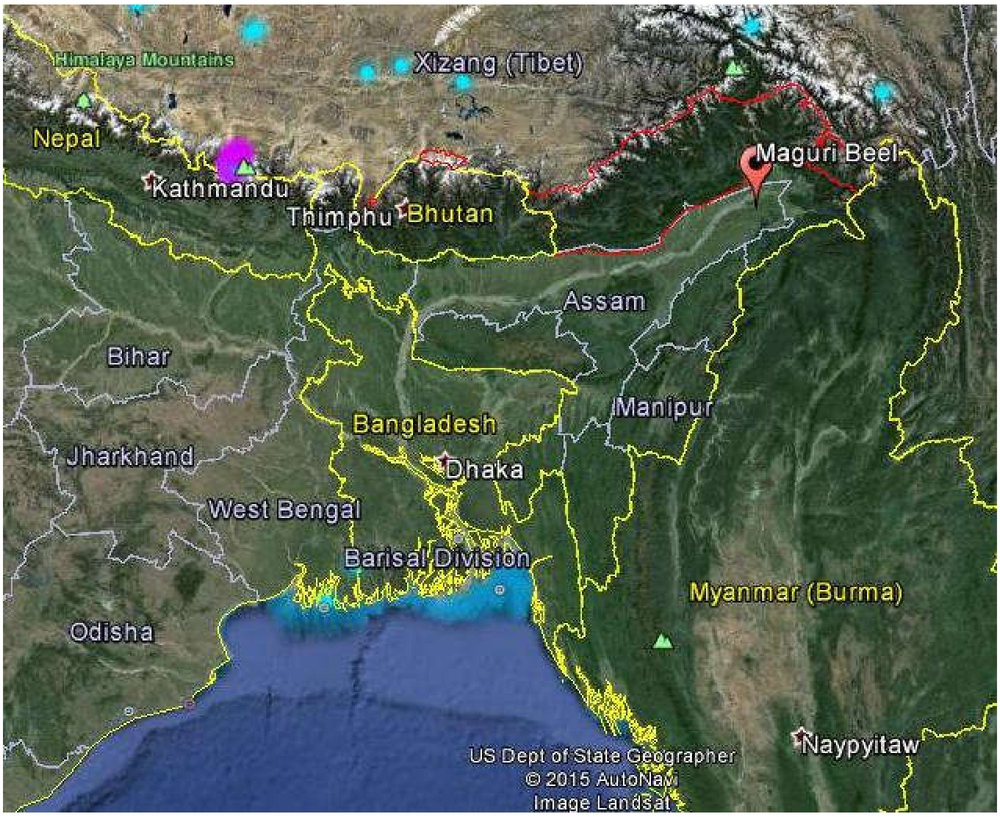

Fig. 1a. Satellite map of the study area – Maguri beel

b. Enlarged view of Maguri beel

Table 3. Table: Status of freshwater mollusc in Maguri beel based on assessment of freshwater mollusc by IUCN, 2012. Table also shows the current status of recorded species in the studied area based on their abundance data

Genus & species	IUCN Red List Category & Criteria (3.1)	Population trend (IUCN,3.1)	Current status in the studied area
Bellamya bengalensis	LC	ST	D
Mekongia crassa	LC	UN	IF
Idiopoma dissimilis	LC	UN	IF
Angulyagra microchaetophora	LC	UN	IF
Angulyagra oxytropis	LC	UN	IF
Pila globosa	LC	UN	R
Pila virens	LC	UN	R
Plotia scabra	LC	UN	IF
Melanoides tuberculata	LC	IN	D
Tarebia granifera	LC	IN	D
Tarebia lineata	LC	UN	D
Brotia costula	LC	UN	IF
Lymnaea acuminata	LC	UN	IF
Intha umbilicalis	LC	ST	IF
Indoplanorbis exustus	LC	UN	IF
Lamellidens corrianus	LC	UN	IF
Lamellidens marginalis	LC	UN	IF
Parreysia corbis	DD	UN	IF
Parreysia smaragdites	LC	UN	IF
Parreysia lima	LC	UN	IF
Parreysia pachysoma	LC	UN	IF
Corbicula assamensis	LC	UN	D
Corbicula striatella	LC	ST	F
Pisidium sp.	LC	UN	F
Sphaerium austeni	NT	UN	IF
Sphaerium indicum	LC	UN	F

Table 4: values of different diversity indices and estimators showing the state of diversity in Maguri beel

Indices and Estimators	Value
Richness (S)	26
Simpson (1-D)	0.886
Shannon (H)	2.46
Evenness (e^H/S)	0.45
Renyi Entropy/ Hill Number	26
(q = 0, 1,2)	11.74
	8.77
Chao 1	26.00
Chao 2	26.00
Jackknife 1	26.93
Jackknife 2	26.99
ICE	26.34
ACE	26.22

*ICE = incidence based converge estimators, ACE = abundance based converge estimators.

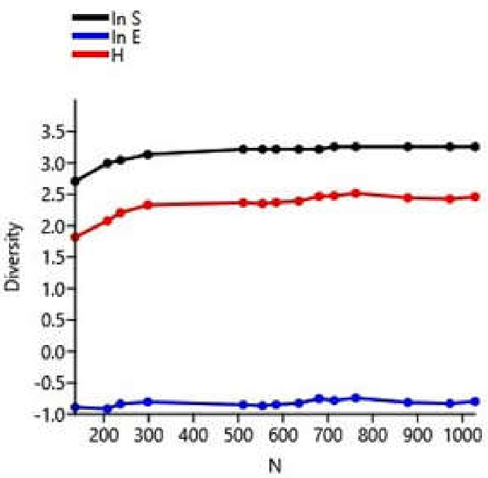

Fig. 2. SHE analysis plots expected pattern for log series distribution in relation to N describing the relationship between components of diversity

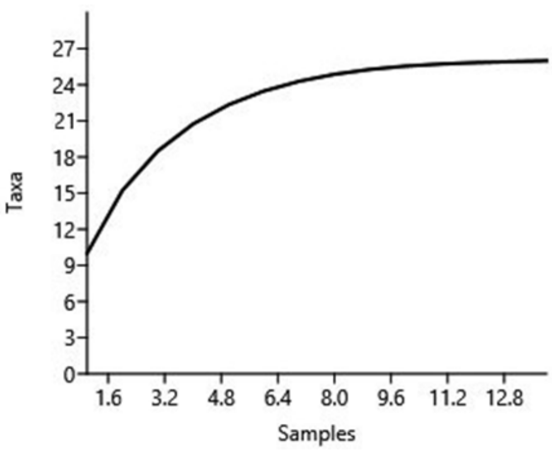

Fig. 3. Sample based rarefaction curve showing the effect of sample size on species richness

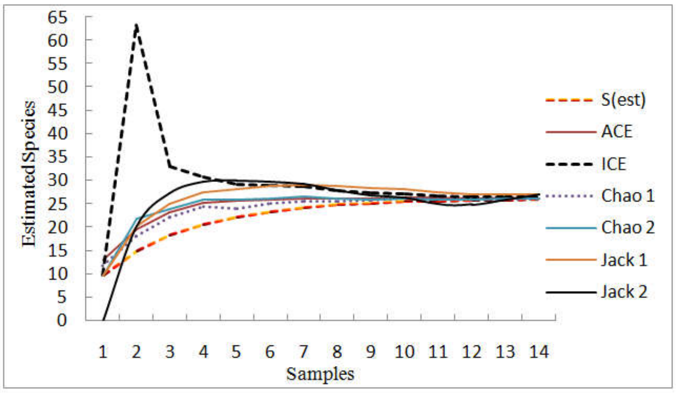

Fig. 4. Graphical presentation showing the different species estimators against sample size

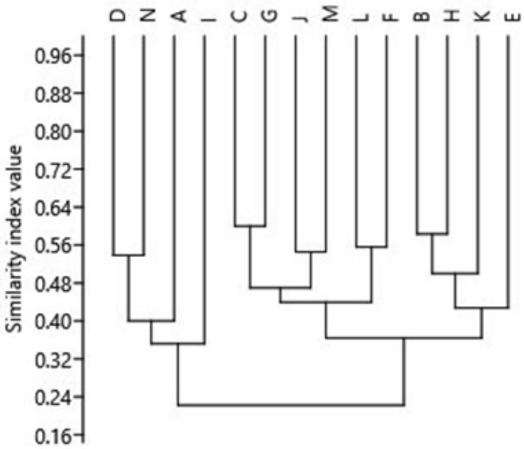

Fig. 5. Hierarchical clustering (UPGMA) of Jaccard similarity index of different sampling stations in Maguri beel

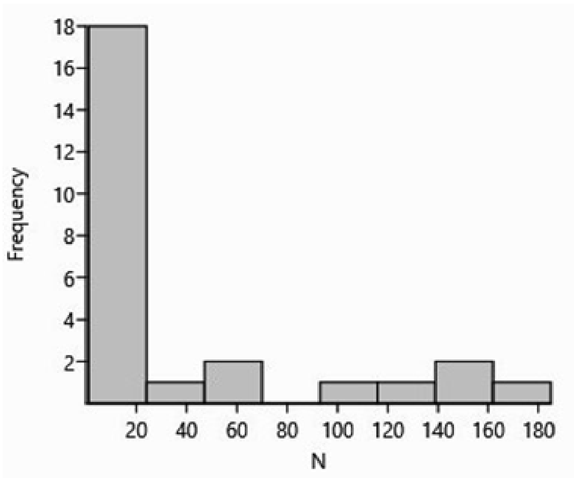

Fig. 6. Frequency of species in relation to abundance in Maguri beel

Table 3 represents the current status of conservation of mollusc species recorded from Maguri beel as per IUCN Red list of threatened species (Version 3.1). The result shows 24 of 26 species recorded are in the category of LC while *Parreysia corbis* (Hanley, 1856) and *S. austeni* are in the category of data deficient (DD) and near threatened (NT) respectively. Similarly, the population trends for most of the recorded species are UN except for the species *M. tubercalata* and *T. granifera* which are increasing (IN) whereas, the species *B. bengalensis, Intha umbilicalis* (Benson, 1836) and *Corbicula striatela* Deshayes, 1854 were found to be stable (ST). Again, of the 26 species, 5 species were dominant, 3 frequent, 16 infrequent, and 2 rare species at the local context.

Species richness, diversity and distribution: The calculated values of various diversity indices are shown in Table 4. Simpson index (1-D =0.886), Shannon index (H = 2.4) shows a good state of diversity whereas the lower value of the evenness index [exp (H)/S=0.45] indicates a relatively uneven distribution of freshwater mollusc in the wetland. The calculation of effective number (Hill Number) of species of order q = 1 shows that less than 50% (11.74) of the species of the total population are homogeneously distributed and less than 35% (8.77) of the total species were dominant (order q = 2). SHE analysis of the samples (Fig. 2) shows that the values of richness (ln of S) initially increases with the increase in diversity (Shannon index H) and evenness (ln E) when the total number of individual (N) was increased which after certain point, richness remained same but with the loss of co linearity with respect to diversity and evenness in the population. By convention, both diversity and evenness follows the same pattern when the total number of individuals (N) increases (irrespective of species richness).

The statistical expectation of species number out of the pooled data set was determined by the sample based rarefaction curve to show the effect of sample size on the species richness (Fig.3). Further analysis of various species estimators also corroborated our findings of recorded species number (Fig.4). These results indicate the adequateness of the sample size of the present survey. Neighbour joining cluster of Jaccard similarity index based on the species richness and abundance in different stations was constructed to find out the similarity between sites in terms of species composition and the result is given in Fig. 5.

DISCUSSION

It is estimated that only about one third of 15,000 freshwater mollusc species have been described and the rest are yet to receive proper attention and valid descriptions (Balian *et al.,* 2008). Of these currently known species, only around 27.7% (1,374) have had their conservation status assessed in the IUCN Red List of threatened species. The report also states that out of 2,306 species of freshwater mollusc assessed globally, 45% of species are threatened (Critically Rare = 291; Endangered = 245; Vulnerable (VU) = 500, total 1,036), 25% species are Data Deficient and 13% species are already extinct. In India, the studies on freshwater molluscs are limited mostly on diversity; distribution and biology and are confined to its southern peninsula as well as in the Indo-Burma region (Subba Rao 1989; Amanullah and Hameed, 1996; Patil and Talmale 2005; Ramakrishna and Dey 2007; Ramesha *et al.* 2013). Budha *et al.* (2010) recorded 112 species of gastropods and 74 species of bivalves (186 species in total) from the Eastern Himalayan region of which about one third (i.e. 32.6%) of the total population is reported to be DD or LC due to lack of information on their current status. Köhler *et al.* (2012) recognized 112 freshwater bivalve species from the Indo-Burma region of which 42.9% fall into LC, 41.1% DD, 5.2% under Critically Endangered, 8.0% EN and 0.9% in VU categories. The data deficient species generally suffers from critical extinction tendency from their natural habitat. Similarly, among 318 gastropod species, 29.5% were under DD, 52.2% under LC and 16.6% was assessed as in the threatened category. The Brahmaputra river basin with enormously large habitat heterogeneity and varied microclimate is expected to harbour unique and endemic species of freshwater molluscs (Budha *et al.* 2010). A total of 26 species recorded from a single wetland (Maguri beel) adjoining the upper Brahmaputra basin represents about 13.97% of total number (186) of species reported from entire Eastern Himalayan region by Budha *et al.* (2010). Our observation during the present study indicates that most of the species (92.3%) recorded were under the category of LC and only 19.23% were with their known status of population trends while rest of the species were with UN population trends as per IUCN Red list Category and Criteria (version 3.1). The present study also provides a different scenario on status of freshwater molluscs in Maguri beel at the local context. It is seen that of the 26 species, 19.23% were dominant, 11.54% frequent, 7.69% rare and rest 61.54% were infrequent. This observation clearly shows the paucity of information and significance of assessment at local context on the status, habitat, distribution and potential threats to the mollusc population of this region. For instance, freshwater mollusc *Parreysia shurtleffiana* (Lea, 1856) is endangered in Nepal, but based on their global distribution it is considered as Least Concern species (IUCN, 2010) and thus reflecting the significance of consideration of local factors for proper assessment of species distribution as well as population trends of a given region.

Species richness is the simplest way to describe community and regional diversity of a population (Magurran, 1988). However, for diversity assessment, the sample size is equally important and should be large enough to describe the entire population of the study area. The adequateness of the sample size of the present study was tested with the help of the SHE analysis (Fig.2), sample based rarefaction curve (Fig.3) and species estimators (Fig.4). The results of this analysis show how the total number of recorded species (26) is conformed to the projected species number. In the present study, diversity indices viz. Simpson (1- D) and Shannon (H) indices show a good state of diversity in the wetland Maguri beel (Table 4). But, when it was compared with effective number of species (Hill No.), only 11.26 (<50%) out of 26 recorded species (richness) were equally abundant (q = 1). The value becomes even lower in case of most abundant species which comprises only 8.12 (35%) (q =2) out of total species number. This means the study area is dominated by few species and rest of the species were rare or infrequent (Fig.6). In case, the effective number of species further drops down at order q = 1 and 2, the species out of effective number range are considered to be in transient state which may be either due to its inability to utilize available resources in the habitat or transformation of habitat parameters to the condition unsuitable to them. With the passage of time, such species become infrequent and attains the status of singleton or doubleton species and finally goes extinct from a particular site. In the present study, we recorded single specimen of *P. virens* (Lamarck, 1822) and two specimens of *P. globosa* (Swainson, 1822) as singleton and doubleton species respectively. The low density of this two species in our sampling may be due to the high predation pressure by aquatic birds and other predators including human being. It may be mentioned that some species of freshwater molluscs are popular food items for local populace (Ganguli *et al.*, 2008).

The diversity and habitat heterogeneity of the surveyed wetland is evident from the species richness and common presence of multiple forms of certain species from families Viviparidae and Planorbidae (Table 2). However, the taxonomical accounts purely based on shell morphology itself are not free from errors. There lies the possibility of categorizing individuals of actually different species of similar morphological characters in the same species and vice-versa. Hence, the molecular identification supported by anatomical and morphological characters would be the only adequate approach for taxonomical classification of freshwater molluscs. The species diversity and richness in an aquatic ecosystem is determined by various factors like resource availability, habitat structure, physico-chemical properties (Hutchinson, 1957; Köhler, 2012; Simoes *et al.*, 2012; Braghin *et al.*, 2015) and also other factors that influence the dispersal and colonization of species (Hubbell, 2001). Habitat heterogeneity is positively associated with higher species diversity and also correlated with increased density of species (Weibull *et al.*, 2000). It has been observed that the study site is characterized by existence of habitat heterogeneity which is evident from neighbour joining cluster of Jaccard similarity index (Fig. 5). The analysis shows the division of sampled stations into three major clusters with similarity index values 0.35-0.40 based on species composition between the sampled stations.

The present study projects Maguri beel as a potential wetland with 26 freshwater mollusc species distributed heterogeneously in the wetland along with other aqua faunal species. The rich faunal diversity of the wetland attracts thousands of migratory birds that sweep away a large mass of shellfishes from its natural habitat every year. The scenario has become more complicated owing to the overharvesting of ichthyofaunal resources from the wetland during the last few years. Moreover, due to reduction of catchment, people solely dependent on this wetland are shifting the secondary source of supplements for their livelihood towards edible mollusc population of the wetland. The man made habitat degradation also making the things worse during the last few years. Therefore, it is the high time for the conservationist and scientific community to recognize Maguri beel as one of the important freshwater mollusc site for conservation of its rich diversity so as to ensure the conservation of other aquatic faunas of the region.

Acknowledgements

The authors are highly thankful to DST (SERB) for financial support, the ZSI, Kolkata for technical support also the Department of Life Sciences, Dibrugarh University for providing necessary facilities for carrying out this study.

REFERENCES

Amanullah, B. and Hameed, P.S. 1996. Studies on molluscan diversity in Kaveri river system (Tiruchirappalli, India) with special reference to vector snails of trematode parasites. *Current Science*, 71: 473-475.

Annandale, N. 1918. Aquatic molluscs of the Inle Lake and connected waters. *Records of the Indian Museum*, 14: 103-182.

Balian, E. V., Segers, H., Leveque, C. and Martens, K. 2008. The Freshwater Animal Diversity Assessment: an overview of the results. *Hydrobiologia*, 595: 627-637.

Bogan, A. E. 2008. Global diversity of freshwater mussels (Mollusca, Bivalvia) in freshwater. *Hydrobiologia*, 595: 139-147.

Braghin, L. S. M., Figueiredo, B. R. S., Meurer, T., Michelan, T. S., Simoes, N. R. and Bonecker, C. C. 2015. Zooplankton diversity in a dammed river basin is maintained by preserved tributaries in a tropical floodplain. *Aquatic Ecology*, 49: 175-187.

Budha, P. B., Aravind, N. A. and Daniel, B. A. 2010. The status and distribution of freshwater molluscs of the eastern Himalayas. In: Allen, D. J., Molur, S., and Daneil, B.A. (Compilers) *The status and distribution of freshwater biodiversity in the Eastern Himalaya, IUCN,* Cambridge, UK and Gland, Switzerland; Zoo Outreach Organisation, Coimbatore, India, pp. 42- 52.

Chakraborty, S., Ray, M. and Ray, S. 2010. Toxicity of Sodium arsinite in the gill of an economically important mollusc of India. *Fish and Shellfish Immunology*, 29: 136-148.

Choudhury, A. U. 1997. The Status of the Birds of Dibru-Saikhowa wildlife sanctuary, Assam, India. *OBC Bulletin*, 25: 27-29.

Choudhury, A. U. 2002. Globally threatened birds in Dibru-Saikhowa Biosphere Reserve. *Himalayan Biosphere Reserves*, 4: 49-54.

Colwell, R. K. 2013. EstimateS: Statistical estimation of species richness and shared species from samples. Version 9. User's Guide and application published at: http://www.purl.oclc.org/estimates.

Connell, J. H. 1978. Diversity in tropical rain forests and coral reefs. Science, 199, 1302-1303.

Cornell, H.V. 1999. Unsaturation and regional influences on species richness in ecological communities: a review of the evidence. *Ecoscience*, 6: 303-315.

F.A.O. 1986. Technical assistance on pearl culture in Bangladesh. TCP/BGD/4508. Field Document1, Project report S2622, p52. http://www.fao.org/docrep/field/003/S2622E/S2622E00.htm. [Accessed October 2013]

Ganguli, P., Boruah, S., Dutta, P. K., Sharma, A. and Biswas, S. P. 2008. Prospects of Ecotourism in Temple Tanks and Floodplain Lakes of Upper Assam. In: Sengupta M, Dalwani R (Editors) (2008) *Proceedings of Taal 2007: The 12th World Lake Conference* , pp. 1329-1332

Graf, D. L. and Cummings, K. S. 2007. Review of the Systematics and Global Diversity of Freshwater Mussel Species (Bivalvia: Unionoida). *Journal of Molluscan Studies*, 73: 291–314.

Hubbell, S. P. 2001. *The unified theory of biogeography and biodiversity*. Princeton Univ. Press.

Hutchinson, G. E. 1957 b. Concluding remarks- Cold Spring Harbor Symposia on Quantitative Biology. 22: 415-427. Reprinted in: Classics in Theoretical Biology. *Bulletin of Mathematical Biology*, 53: 193-213.

International Union for Conservation of Nature 2010. http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T173146A6964859.en

Köhler, F., Seddon, M., Bogan, A. E., Tu, D. V., Aroon, P. S. and Allen, D. 2012. The status and distribution of freshwater molluscs of the Indo-Burma region. In: Allen DJ, Smith KG, Darwall WRT (Compilers) *The status and distribution of freshwater biodiversity in Indo-Burma, IUCN,* Cambridge, UK and Gland, Switzerland; Zoo Outreach Organization, Coimbatore, India, pp. 67-85.

Kumar, A. and Vyas, V. 2012. Diversity of Molluscan community in River Narmada, India. *Journal of Chemical Biological and Physical Sciences*, 2: 1407-1412.

MacArthur, R. H. and Wilson, E. O. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton.

Magurran, A.E. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton, U.S.A

Patil, S. G. and Talmale, S. S. 2005. A checklist of land and freshwater molluscs from Maharashtra State. *Zoo's Print*, 20: 1912-1913.

Prashad, B. 1920. Notes on Lamellibranchs in the Indian Museum. *Records of the Indian Museum*, 19: 165-173.

Prashad, B. 1928. Revision of the Asiatic species of the genus Corbicula 1. The Indian species of Corbicula. *Memories of Indian Museum*, 9: 13-27.

Preston, H. B. 1915: *The Fauna of British India including Ceylon and Burma*. Mollusca (Freshwater Gastropoda and Pelecypoda) Taylor and Francis, London.

Rajan, M. K. and Marrugan, N. 2001. Diversity of Molluscan Fauna of Arjuna River relation to pollution, Sivakashi, Tamilnadu. *Journal of Aquatic Biology*, 16: 5-9.

Ramakrishna, and Dey, A. 2007. *Handbook on Indian Freshwater Molluscs*. Zoological Survey of India, Kolkata.

Ramesha, M. M., Sophia, S. and Muralidhar, M. 2013. Freshwater Bivalve Fauna in the Western Ghats Rivers of Karnataka, India: Diversity, Distribution Patterns, Threats and Conservation Needs. *International Journal of Current Research*, 5: 2500-2505.

Sicuro, B. 2015. Freshwater bivalves rearing: a brief overview. *International Aquatic Research*, 7: 93-100.

Simões, N. R., Lansac-Tôha, F. A., Velho, L. F. and Bonecker, C. C. 2012. Intra and inter-annual structure of zooplankton communities in floodplain lakes: a long-term ecological research study. *Revista de Biologia Tropical*, 60: 1819-36.

Stevens, G. C. 1989. The latitudinal gradient in geographical range: how so many species coexist in the tropics.Am. *Naturalist*, 133: 240-256.

Strong, E. E., Gargominy, O., Ponder, W. F., Bouchet, P. 2008. Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. *Hydrobiologia*, 595: 149-166.

Subba Rao, N.V. 1989. *Handbook of Freshwater Molluscs of India.* Zoological Survey of India, Kolkata.

Weibull, A. C., Bengtsson, J. and Nohlgren, E. 2000. Diversity of butterflies in the agricultural landscape: the role of farming system and landscape heterogeneity. *Ecography*, 23: 743–750.

****