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Habitat diversity of freshwater snail in Goalpara district, India

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Abstract: Freshwater snail, *Viviparous viviparous* constitutes a component of the tribal diet of Goalpara district, India, where tribal community *viz.* Rabha, Boro, Garo, Hazong (36.10%) lives together. They normally collect snail from natural sources and are not aware of snail farming technology. Snail habitats are naturally degraded due to various reasons viz. degradation of aquatic environment due to shrinkage of water bodies, eutrophication, human interferences, use of agrochemicals in modern agricultural practices and animal husbandry. An investigation was conducted during 2010-2011 on freshwater snail habitats in the district. Five habitats*viz.* (i) shallow stagnant water body, (ii) slow moving water body, (iii) *beel*, (iv) rice-field and (v) river, were identified. Environmental parameters *viz.* pH, dissolved oxygen, carbon-dioxide, hardness, temperature, water movement, vegetation and co-relation analysis was done against snail population. Highest population was found in riverine habitat (100 numbers in 23 sampling in a year) followed by *beel* habitat (90 numbers in 23 sampling in a year), stagnant water body (88 numbers in 20 sampling in a year), rice-field (76 numbers in 15 sampling in a year), slow moving water body (59 numbers in 15 sampling in a year). The analysis reveals that water movement, pH, depth and vegetation are the responsible environmental factors for snail population. Snail population was found higher within the range of pH 5.4-6.5,depth 0.1-0.5m.The study indicates that snail population is higher in riverine habitat due to continuous supply of running water which carries food for snails in the form of dead algae and second highest in beels which are infested with aquatic vegetation that provides feeds for snail. The study reveals that feed and other environmental parameters *viz.*, water movement, pH, depth, are the limiting factors for snail population in the natural sources.The study suggested that the snail habitats may be managed in an eco-friendly way for conservation of snail species, aquatic biodiversity and an environment for production of animal proteins for the local populace.

Keywords: *Viviparous viviparous*, freshwater snail, habitats, diversity.

INTRODUCTION

Goalpara district (25^{o}– $28^{/}$ N to $26^{o}54^{/}$ N latitude and $89^{o}50^{/}$East to $90^{o}06^{/}$ East longitude)falls under the Indo-Burma biodiversity hotspot, that encompasses 2,373,000 km² of tropical Asia, now been redefined as the Indo-Chinese sub region. The district is situated in thewestern part of Assam, India. The Brahmaputra is flowing all along through northern border of the district, while the southern border is surrounded by the Foot Hills of Maghalaya. In the eastern side, there is Kamrup district and Dhubri district of Assam in the west. The geographical area of the district is 182462 ha (1824.62 Sq. Km.). The District Head Quarter, Goalpara town, is situated 150 km west of the state capital Guwahati and connected through National High way No.-37. The district is rich both in terrestrial and aquatic biodiversity. Fresh water snail forms important component of aquatic lives and daily diet of the tribal people of the district. Although, snail farming is gaining popularity in various part of the globe [1], people of North Eastern India are not aware of the snail farming technology. They mostly depend on wild catch for daily consumption. This practice combined with various development programmes and modern agricultural practices negatively impacted the snail population. A study was designed and conducted to investigate the snail habitats and population of snail in various habitats in the district.

MATERIAL AND METHODS

The study was conducted in eight rural development blocks of Goalpara district, India, during 2010-2013. Five aquatic habitats *viz.*, (i) shallow stagnant water body and (ii) slow moving shallow water bodies (iii) *beel*, (iv) rice-field and(v) river were assessed in terms of depth, water movement, pH, temperature, dissolved oxygen, carbon-dioxide, hardness, and vegetation. Snail population was estimated following Olivier and Schneiderman[10]. The primary data were summarised using descriptive statistics and the results were complemented by the information and statistics gathered from secondary sources. The estimates of variables (*e.g.* mean number of snails) were calculated from these guesstimates are indicative, not definitive.

The habitats investigated during the study are described below:

(i) Shallow stagnant water body:

Water stagnation occurs when stops flowing. Stagnant water can be dangerous as it provides better incubator for numbers of bacteria and parasites. Moreover it is often contaminated with human and animal faces, which can cause zoonotic disease. Stagnant water can also cause environmental hazard. *Nelumbonucifera, Nymphaeanouchali, Nymphaearubra*etc. are the common vegetation in stagnant water body.

(ii) Slow moving shallow water body:

This type of habitat is characterized by warm daytime temperatures, combined with shallow depth and slow watercurrent. These characters contribute to increase of algae growth, resulting in the quick formation of bloom. The bloom can last up to three weeks and the wind can often cause them to shift around a body of water.

(iii) *Beel*:

Changing courses of rivers created numbers of water sheets which are locally known as *beel*. Eutrophication and siltation caused mainly by water hyacinth are the major concern for ecological degradation of *beel*s. This has been further enhanced by dams and roads constructed under various development programme resulting into shrinkage of the size of *beel*s. Ecosystem processes in a beel is determined by - (a) morphometric and hydrodynamics,(b) physico-chemical property and (c) biological characters. The energy produced at the primary stage *i.e.* phytoplanktons and macrophytes are transformed into higher trophic level through food chains. In *beel*, two main pathways *viz*. the grazing chain and the detritus chain are found. *Beel*s of the Goalpara district are rich in snail diversity and it harbours almost all freshwater species available in North Eastern region of India.

(iv) Rice field:

It is rain fed lowland generally used for rice cultivation. It is dependent on duration of rainfalland thusa seasonal waterlogged situation with uncontrolled shallow depth, ranging from 1-50 cm.

(v) River:

A river is a natural watercourse, freshwater, usually flowing towards an ocean. River is part of the hydrological cycle. The water in a river is usually confined to a channel, made up of a stream bed between banks. There is also a wider floodplain shaped by flood-waters over-topping the channel.

RESULTS

The result of study established the report of Borkakoti *et al.* [2] which stated that there are 29 species of snails in Assam is presented in Table 1. All of them are also available in Goalpara district. Freshwater snails play a significant role in the freshwater ecosystems as a part of the detritus food chain. The investigation on different habitats revealed that most of the snail habitats are deteriorated. The present characteristics of the habitats are summarized in Table 2.

Movement of water, temperature, pH, depth and aquatic vegetation are the major factors that influence the snail population. The population was lowest in slow moving water bodies where temperature ranged between 28 – 31^{0}C, pH 4.2 – 5.5 and depth 0.12 – 0.30 m. In comparison to slow moving water bodies, population was higher in rice field, where temperature ranged between 29 – 33^{0}C, pH 4.4 – 6.5 and depth 0.01 – 0.57 m. The highest population was observed in riverine habitat, where temperature ranged between 29 – 33^{0}C, pH 5.4 – 6.5 and depth 0.1 – 0.5 m (snail zone). Second highest population was found in *beel*, where temperature ranged between 29 – 33^{0}C, pH 4.4 – 6.5 and depth 0.17 – 0.57 m (snail zone). Stagnant water, where temperature ranged between 29 – 33^{0}C, pH 5.4 – 6.5 and depth 0.10 – 0.15 m, showed third highest population of snail. The study revealed that water movement and feed availability are the major factors for snail population. The population was highest in riverine situation where continuous supply of feed in the form of dead algae is available and second highest in *beel* where aquatic vegetation is more. Water pH plays a significant role on snail population. Where pH is low snail population is low. Optimum temperature was observed to be 29 – 33^0 C.

Abundance of *Viviparous viviparous* is presented in Table 3 which reveals highest population in riverine habitat amounting to 100 numbers followed by 90 numbers in *beel* habitat during 23 samplings during 2010-2011. Due to seasonality of the water bodies samples could be collected 20 times in stagnant water bodies during 16th April 2010 to 1st February 2011(month),15 times in slow moving water during 16th April 2010 to 16th November 2011(month) and 15 times in rice field during 16th April 2010 to 16th November 2011(month) and the number of snails collected were 88, 59 and 76, respectively. The mean population per habitat was 4.40, 3.39, 3.91, 5.07 and 4.35 for Habitat 1,2,3,4 and 5,respectively. While minimum catch was 0.00 in all the habitats, maximum was 8, 8, 8, 9 and 10 in Habitat 1, 2, 3, 4, and 5, respectively. The highest population in riverine habitat was probably due to continuous supply of running water.

Analyses of simple correlations amongst the independent variables were done and results are presented in Table-4 (Habitat-1, Shallow stagnant water body). Positively significant correlations were observed between snail and hardness (r = (+) 0.722, $p < 0.01$), snail and temperature (r = (+) 0.796, $p < 0.01$), snail and depth (r = (+) 0.641, $p < 0.01$), snail and vegetation (r = (+) 0.982, $p < 0.01$); carbon-dioxide and hardness (r = (+) 0.532, $p < 0.05$); hardness and temperature (r = (+) 0.736, $p < 0.01$), hardness and depth (r = (+) 0.650,$p < 0.01$), hardness and vegetation (r = (+) 0.751, $p < 0.01$), depth and vegetation (r = (+) 0.705, $p < 0.01$).

Analysis of simple correlations amongst the independent variables was done and results are presented in Table-5 (Habitat-2, Slow moving shallow water body). Positively significant correlations were observed between snail and temperature (r = (+) 0.588, $p < 0.01$), snail and depth (r = (+) 0.560, $p < 0.01$), snail and water movement (r = (+) 0.648, $p < 0.01$), snail and vegetation (r = (+) 0.955, $p < 0.01$); temperature and depth (r = (+) 0.862, $p < 0.01$), temperature and water movement (r = (+) 0.760, $p < 0.01$), temperature and vegetation (r = (+) 0.588, $p < 0.05$); depth and water movement (r = (+) 0.775, $p < 0.01$), depth and vegetation (r = (+) 0.564, $p < 0.05$); water movement and vegetation (r = (+) 0.609, $p < 0.05$).

Negatively significant correlations were observed between snail and hardness (r = (-) 0.602, $p < 0.01$), pH and dissolve carbon-dioxide (r = (-) 0.833, $p < 0.01$), hardness and snail (r = (-) 0.602, $p < 0.05$), hardness and water movement (r = (-) 0.660, $p < 0.01$).

Analysis of simple correlations amongst the independent variables was done and results are presented in Table-6 (Habitat-3, *Beel*). Positively significant correlations were observed between snail and hardness (r = (+) 0.521, $p < 0.05$), snail and temperature (r = (+) 0.499, $p < 0.05$), snail and depth (r = (+) 0.506, $p < 0.05$), snail and vegetation (r = (+) 0.932, $p < 0.01$); dissolved oxygen and vegetation (r = (+) 0.474, $p < 0.05$); carbon-dioxide and hardness (r = (+) 0.503, $p < 0.05$); hardness and depth (r= (+) 0.649, $p < 0.01$), hardness and vegetation (r = (+) 0.649, $p < 0.01$); temperature and vegetation (r = (+) 0.528, $p < 0.01$); depth and water movement (r= (+) 0.528, $p < 0.01$).

Analysis of simple correlations amongst the independent variables was done and results are presented in Table-7 (Habitat-4, Rice-field). Positively significant correlations were observed between snail and pH (r = (+) 0.879,$p<0.01$), snail and temperature (r= (+) 0.598, $p < 0.05$), snail and depth (r = (+) 0.523, $p < 0.05$), snail and water movement (r = (+) 0.650, $p < 0.01$), snail and vegetation (r = (+) 0.929, $p < 0.01$); pH and snail (r = (+) 0.879, $p < 0.01$), pH and temperature (r = (+) 0.543, $p < 0.05$), pH and depth (r = (+) 0.517, $p < 0.05$), pH and water movement (r = (+) 0.688, $p < 0.01$), pH and vegetation (r = (+) 0.917, $p < 0.01$); temperature and depth (r = (+) 0.890, $p < 0.01$); temperature and water movement (r = (+) 0.925, $p < 0.01$), temperature and vegetation (r = (+) 0.548, $p < 0.05$); depth and water movement (r = (+) 0.775, $p < 0.01$); water movement and vegetation (r = (+) 0.674,$p<0.01$).

Negatively significant correlation were observed between snail and hardness (r = (-) 0.897, $p < 0.01$); pH and hardness (r = (-) 0.827, $p < 0.01$); hardness and vegetation (r = (-) 0.798, $p < 0.01$).

Analysis of simple correlations amongst the independent variables was done and results are presented in Table 8 (Habitat-5, River). Positively significant correlations were observed between snail and pH (r = (+) 0.659, $p < 0.01$), snail and temperature (r = (+) 0.525, $p < 0.05$), snail and water movement (r = (+) 0.560, $p < 0.01$), snail and vegetation (r = (+) 0.990,$p<0.01$); pH and temperature (r = (+) 0.508, $p<0.05$), pH and water movement(r=(+) 0.479,$p< 0.05$), pH and vegetation (r = (+) 0.665, $p < 0.01$); hardness and temperature (r = (+) 0.556, $p < 0.01$); hardness and depth (r = (+) 0.894, $p < 0.01$); hardness and water movement (r = (+)0.737, $p < 0.01$); temperature and depth (r = (+) 0.688, $p < 0.01$); temperature and water movement (r = (+) 0.787, $p < 0.01$), temperature and vegetation (r = (+) 0.563, $p < 0.01$); depth and water movement (r = (+) 0.83075, $p < 0.01$); water movement and vegetation (r = (+) 0.580, $p < 0.01$).

Only one negatively significant correlation was observed between dissolved carbon-dioxide and hardness (r = (-) 0.554, $p < 0.05$) in the riverine habitat.

Table-1: Freshwater snails of North-East India

Name of Gastropods	Abundance	Remarks
1.Basomatophora		
Family -Lymnaedae		
Lymnealuteolafimpura	+++	Non-edible
L. acuminate f. refuscens	++	Non-edible
L. acuminate f. gacilior	++	Non-edible
L. luteola f. ovalis	++	Non-edible
L. luteola f. typica	+++	Non-edible
Family - Planorbidae		
Indoplanorbisexustus	+++	Non-edible
2.Order- Mesogastropoda		
Family-Bithyniidae		
Digniostomacerameopema	+	*Non-edible*
Family-Viviparidae		
Angulyagraoxytropis	++	Non-edible
Bellamyabengalensis	+++	Edible
B. bengalensis f. typica	+++	Edible
B. bengalensis f. balteata	+++	Edible
B. dissimilis	+++	Edible
Cipangopaludinalecithis	+	Non-edible
Family- Pilidae		
Pilaglobosa	+++	Edible
P.scuata	++	Edible
P. theobaldi	++	Edible
P. viren	++	Edible
Family-Thiaridae		
Brotiacostula	+++	Edible
Paludomusconica	++	Non-edible
Thiaralineata	++	Non-edible
T. tuberculata	++	Non-edible
T. scabra	++	Non-edible
Sulcospirahugeli	++	Non-edible
Paludomuspustulosa	++	Non-edible
P. reticulate	++	Non-edible
T. granifera	+	Non-edible
Family- Cyclophoridae		
Cyclophorusbensoni	+	Non-edible
3.Order- Stylomataphora		
Family- Achatinidae		
Achatinafulida	+++	Non-edible
Family-Ariophantidae		
Macrochlamysindica	+	Non-edible

1. Source; State Biodiversity Strategy and Action plane, Assam, 2002.
2. +++ = High; ++ = Medium; + = Poor

Table-2: Habitat characteristics.

Sl. No.	Habitat-1	Habitat-2	Habitat-3	Habitat-4	Habitat-5
Snail.spp.	*Viviparaus viviparous, Pilaglobosa, P. theobaldi P. viren P. scutata.*	*Pilaglobosa, P. theobaldi, V.viviparaus*	*Viviparaus viviparous, Pilaglobosa, P. theobaldi, P. viren and P. scutata*	*V. viviparous Pilaglobosa, P. theobaldi, P. viren and P. scutata*	*Paludomus reticulate, P. pastulosa P. conica, P. scutata, Brotiacostula Thiaratuberculata.*
vegetation	*Pistiastratiotes, Lemnaminor , Eichhorniacrassipes, Salvaniacucullata, Wolfiaarhiza, Lemnapausicostata, Lemna sp., Eichhorniacrassipes, Pistia sp., Hydrocharis cellulose, Ludwigiaadcendens Trapabispinosa.*	*Azollapinnata , Ceratopterist halictroides, Anabaena orientalis, Charazeylanica, Hydrodictyon indicum, Nostoclinkia, Spirogyra elongate, Oscillatoria Formosa.*	**Free floating Macrophytes** *Salvaniacucullata , Wolfiaarhiza Lemnapausicostata Lemnapausicostata, Lemna sp., Eichhorniacrassipes, Pistia sp., Hydrocharis cellulose, Ludwigiaadcendens Trapabispinosa.* **Amphibians** *Cyperusrotundus, Enhydraflactuans Epomoea aquatic Epomoeacarnea Sagittariasagittifolia Scirpus articulates Butomusumbellatus Colocasiafornicata Monochoriahostata Marsileaquadrifolia*	*Pistiastratiotes, Lemna minor, Eichhorniacrassipes, Salvaniacucullata, Wolfiaarhiza, Lemnapausicostata, Lemnapausicostata, Lemna sp., Eichhorniacrassipes, Pistia sp., Hydrocharis cellulose, Ludwigiaadcendens, Trapabispinosa.*	**Free floating Macrophytes** *Salvaniacucullata, Wolfiaarhiza, Lemnapausicostata, Lemna sp., Eichhorniacrassipes Pistia sp., Hydrocharis cellulose, Ludwigiaadcendens, Trapabispinosa.* **Amphibians** *Cyperusrotundus, Enhydrafflactuans, Epomoea aquatic, Epomoeacarnea Sagittariasagittifolia Scirpus articulates Butomusumbellatus Colocasiafornicata Monochoriahostata Marsileaquadrifolia*
Human influence	Fishing Swimming, Washing clothes and utensils	Fishing	Fishing Swimming, Washing clothes and utensils	Fishing	Bathing, Fishing Animal bath, Swimming, Washing clothes and utensils
Grazing animal	Cow, pig, duck, Sheep	Cow, pig	Cow, pig, sheep	Cow, pig, sheep	Cow, pig, horse, sheep
Water depth	0.10-0.15m	0.12-0.30m	0.17 -0.57m	0.01-0.57m	0.1-0.5m
Water pH	5.4-6.5	4.2-5.5	5.4-6.5	4.4-6.5	5.4-6.5
Water temperature	29^oC -33^oC	28^oC -31^oC	27.52^oC -31^oC	29^oC -33^oC	29^oC -33^oC
DO_2	3.9-7.25	3.9-7.25	3.9-7.25	3.9-7.25	3.9-7.25
Free C_2O	1.24-3.3	1.24-3.3	1.24-3.3	1.24-3.3	1.24-3.3

Habitat-1 (Shallow stagnant water body),habitat-2(Slow moving shallow water),habitat-3(beel), habitat-4(rice-field), habitat-5(river)

Table-3: Abundance of *Viviporous visiporous*

		Period	Stagnant	Slow moving	Beel	Rice-field	River
N	Valid	23	20	15	23	15	23
	Missing	0	3	8	0	8	0
Mean			4.4000	3.9333	3.9130	5.0667	4.3478
Std. Error of Mean			0.67434	0.59735	0.61891	0.65804	0.58509
Std. Deviation			3.01575	2.31352	2.96821	2.54858	2.80598
Variance			9.095	5.352	8.810	6.495	7.874
Range			8.00	8.00	8.00	9.00	10.00
Minimum			0.00	0.00	0.00	0.00	0.00
Maximum			8.00	8.00	8.00	9.00	10.00
Sum			88.00	59.00	90.00	76.00	100.00

Table-4: Correlations amongst the independent variables (Habitat-1, shallow stagnant water body)

	Snail	pH	DO	CO2	Hardness	Temperature	Depth	Watermovement	Vegetation
Snail	1.000	-0.118	0.336	0.385	0.722**	0.796**	0.641**	.a	0.982**
pH	-0.118	1.000	-0.294	0.174	0.424	0.232	0.285	.a	-0.004
DO	0.336	-0.294	1.000	0.208	0.058	0.382	0.273	.a	0.402
CO2	0.385	0.174	0.208	1.000	0.532*	0.381	0.247	.a	0.436
Hardness	0.722**	0.424	0.058	0.532*	1.000	0.736**	0.650**	.a	0.751**
Tem	0.796**	0.232	0.382	0.381	0.736**	1.000	0.902**	.a	0.847**
Depth	0.641**	0.285	0.273	0.247	0.650**	0.902**	1.000	.a	0.705**
Water movement	.a	.a	.a	.a	.a	.a	.a	.a	.a
Vegetation	0.982**	-0.004	0.402	0.436	0.751**	0.847**	0.705**	.a	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table-5: Correlations amongst the independent variables (Habitat-2, slow moving shallow water body)

	Snail	pH	DO	CO2	Hardness	Temperature	Depth	Watermovement	Vegetation
Snail	1.000	-0.057	-0.078	0.271	-0.602*	0.588*	0.560*	0.648**	0.955**
pH	-0.057	1.000	-0.012	-0.833**	0.046	0.259	0.361	0.369	-0.092
DO	-0.078	-0.012	1.000	0.255	0.202	0.250	0.136	0.025	0.058
CO2	0.271	-0.833**	0.255	1.000	-0.054	0.019	-0.034	-0.183	0.328
Hardness	-0.602*	0.046	0.202	-0.054	1.000	-0.328	-.0198	-0.660**	-0.484
Tem	0.588*	0.259	0.250	0.019	-0.328	1.000	0.862**	0.760**	0.558*
Depth	0.560*	0.361	0.136	-0.034	-0.198	0.862**	1.000	0.775**	0.564*
Watermovement	0.648**	0.369	0.025	-0.183	-0.660**	0.760**	0.775**	1.000	0.609*
Vegetation	0.955**	-0.092	0.058	0.328	-0.484	0.558*	0.564*	0.609*	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table-6: Correlations amongst the independent variables (Habitat -3, *Beel*)

	Snail	pH	DO	CO2	Hardness	Temperature	Depth	Water movement	Vegetation
Snail	1.000	0.063	0.397	0.309	0.521*	0.499*	0.506*	0.076	0.932**
pH	0.063	1.000	-0.203	0.238	0.309	-0.138	0.230	0.206	0.198
DO	0.397	-0.203	1.000	0.170	-0.039	0.228	0.227	0.223	0.474*
CO2	0.309	0.238	0.170	1.000	0.503*	0.067	0.246	0.065	0.304
Hardness	0.521*	0.309	-0.039	0.503*	1.000	0.105	0.649**	0.329	0.532**
Tem	0.499*	-0.138	0.228	0.067	0.105	1.000	0.050	-0.087	0.528**
Depth	0.506*	0.230	0.227	0.246	0.649**	0.050	1.000	0.362	0.528**
Water movement	0.076	0.206	0.223	0.065	0.329	-0.087	0.362	1.000	0.131
Vegetation	0.932**	0.198	0.474*	0.304	0.532**	0.528**	0.528**	0.131	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table-7: Correlations amongst the independent variables (Habitat-4 Rice-field)

	Snail	pH	DO	CO2	Hardness	Temperature	Depth	Watermovement	Vegetation
Snail	1.000	0.879**	0.172	-0.045	-0.897**	0.598*	0.523*	0.650**	0.929**
pH	0.879**	1.000	0.115	-0.148	-0.827**	0.543*	0.517*	0.688**	0.917**
DO	0.172	0.115	1.000	0.255	-0.269	0.015	0.136	0.025	0.016
CO2	-0.045	-0.148	0.255	1.000	-0.124	-0.022	-0.034	-0.183	-0.269
Hardness	-0.897**	-0.827**	-0.269	-0.124	1.000	-0.423	-0.424	-0.503	-0.798**
Tem	0.598*	0.543*	0.015	-0.022	-0.423	1.000	0.890**	0.925**	0.548*
Depth	0.523*	0.517*	0.136	-0.034	-0.424	0.890**	1.000	0.775**	0.469
Watermovement	0.650**	0.688**	0.025	-0.183	-0.503	0.925**	0.775**	1.000	0.674**
Vegetation	0.929**	0.917**	0.016	-0.269	-0.798**	0.548*	0.469	0.674**	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table-8: Correlations amongst the independent variables (Habitat-5, River)

	Snail	pH	DO	CO_2	Hardness	Temperature	Depth	Water movement	Vegetation
Snail	1.000	0.659**	0.193	0.026	0.108	0.525*	0.284	0.560**	0.990**
pH	0.659**	1.000	0.192	-0.172	0.240	0.508*	0.335	0.479*	0.665**
DO	0.193	0.192	1.000	0.245	-0.029	0.197	0.053	0.034	0.204
CO2	0.026	-0.172	0.245	1.000	-0.554**	0.007	-0.272	-0.251	0.001
Hardness	0.108	0.240	-0.029	-0.554**	1.000	0.556**	0.894**	0.737**	0.114
Tem	0.525*	0.508*	0.197	0.007	0.556**	1.000	0.688**	0.787**	0.563**
Depth	0.284	0.335	0.053	-0.272	0.894**	0.688**	1.000	0.830**	0.292
Watermovement	0.560**	0.479*	0.034	-0.251	0.737**	0.787**	0.830**	1.000	0.580**
Vegetation	0.990**	0.665**	0.204	0.001	0.114	0.563**	0.292	0.580**	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

The district has 3,671 ha *Beels* (56 numbers; Registered 17 and unregistered 39), 3,970 ha other wetlands (swamp/derelicts and water logged area) and 18,269 ha seasonally flooded rice field [3]. Livelihoods of the people of surrounding villages basically depend on the resources available in these water bodies.

Freshwater snails are ubiquitous throughout the Goalpara district, India. It is important to understand the degree to which environmental factors, both biotic and abiotic, contribute to variation in snail abundance and distribution, within and among shallow stagnant water body, slow moving water body, *beel*, rice-field, and river. Predation is an important biotic factor that may affect the abundance and distribution of prey directly by consumption [4-5] or indirectly by altering prey behaviour *i.e.* habitat use, foraging; [6-7] and reproductive success[8-9].

CONCLUSION

It is concluded from the study that since the local people are fond of snails and snail population is declining day by day, sail habitat management and introduction of snail culture in the district as a component of aquaculture is imperative. Therefore, snail farming may be encouraged by educating the people through training, seminar and conference on rearing techniques, its medicinal and nutritive values and return on investment. Snail retailers may be encouraged to form marketers groups and recognized as aqua-product marketers. Govt. Department of Fisheries may formulate policies for snail aquaculture to increase snail production, poverty reduction and snail habitat conservation.

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