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MORPHOMETRIC VARIATIONS ON APPLE SNAIL PILA GLOBOSA (SWAINSON, 1822) AT FORAGING SELECTED SITE OF ASIAN OPENBILL STORK ANASTOMUS OSCITANS IN SEMBANARKOIL REGION, NAGAPATTINAM DISTRICT, TAMILNADU, INDIA

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Abstract:

The present study was conducted on Morphometric variations of Apple Snail *Pila globosa* (Swainson, 1822) at foraging selected site of Asian Openbill Stork *Anastomus oscitans* in Sembanarkoil region, Nagapattinam District, Tamilnadu, India from October 2016 to September 2017. The shell length (3.56 ± 1.05 cm), shell width (2.90 ± 0.93 cm), Aperture length (2.59 ± 0.89 cm), Aperture width (1.39 ± 0.50 cm) and Shell thickness (1.33±0.66 mm) were observed. The total weight in wet condition and (33.14±11.86g) and total weight in dry condition (13.08±4.90g) were also recorded. A Principal Components Analysis (PCA) was made in order to consider character inter- correlations. Considerable variation was found in morphometry amidst the habitat. The difference in mean shell length between the riverine habitat and agriculture habitat was highly significant. The length and weight relationship was found that allometric growth pattern in among the habitat while variation was found in agriculture habitat. The further study needed the morphometric study of *P. globosa* in relation to non-foraging site and size of prey chosen by Asian Openbill Stork.

Key Words: *Anastomus Oscitans*, *Pila Globosa*, Shell Length, Length-Weight & Agriculture

1. Introduction:

Wetlands support several species of water birds and each species use available habitats and resources in different ways. In the aquatic landscape some of place the availability of food resources is distributed regular, random and clumped (Jacobson et al.2015). All organisms have different food requirement. This is differ basis on food habit. Therefore all the birds face a number of problem during the feeding such as where and how long to feed in the habitat. The interest to study what food item to select and the availability of prey item of large wading bird.

The globally nineteen species of storks are found, in which nine species occurred in India (Hancock et al.1992). The Asian Open Bill Stork (*Anastomus oscitans*) is a large wading bird in the stork and found as a resident colonial breeder. It is distributed in the Indian subcontinent and Southeast Asia (Ali and Ripley 1987) . The Asian Open bill Stork is smallest and commonest of the storks among all other bird species. Many studies have been focused on food and feeding behavior of Asian openbill stork and a survey of the literature indicate that shelled mollusus principally snails of the genus Pila species make up a major portion of prey taken (Kahl 1971, Ali and Ripley 1987, Anam et al.2016). Therefore Morphometric study of Apple Snail *Pila globosa* at foraging selected site of Asian Openbill Stork is likely to be significant for understand the availability of size and length-weight of prey in the different habitats and also it is least concern (Birdlife International 2001).

The gastropods are the largest class of molluscs and are the most highly diversified rich the phylum, with 65,000 to 80,000 living snail and slug species (Bouchet et al. 2005, Strong et al.2009). It is represented a major biotic component in ecosystem. Many gastropods species are also good bio-indicators for pale environments as well as for pollution on the basis of their adaptive extremes conditions (Edmondson et al.2010, Druart et al.2011). Therefore both biotic factors and abiotic factors can produce selective pressures that can affect the morphology of organisms (Eschweiler et al.2008). Shell's morphology has various shapes that contribute to species identification, classification and taxonomic information (Moneva et al. 2012, Morais et al 2013). The analysis of morphological characters such as the length-weight relationship of species is useful in freshwater ecosystem for management and also important to determine population condition (Saleky et al. 2016). The difference of gastropod shell morphology are influenced by different factors are involved such as substrate type and temperature (Dmitrović et al.2016), pollution (Jordaens et al. 2006, Urra et al. 2007) self-protection from of predator, and depth variation (Olabarria and Thurston 2003; Marquez et al. 2011). The length-weight relationships have been broadly investigated in gastropod to obtain the index of the populations and evaluate habitat quality (Albuquerque et al. 2009). Species identification based on shell's morphometry is quite difficult because morphology and color patterns of the shell are affected by the changes in environment factor (Mauro et al. 2003).

The Apple Snail *Pila globosa* (Swainson, 1822) is a freshwater mollusc with an operculam and aquatic gastropod belongs to family ampullariidae. They widely distributed from Nepal, Southwesten Asia, Africa North and South America. It is common species in India except Southern India and Punjab (Subba Rao and Dev 1989, Sreejith 2014). In India, various freshwater snail species have been reported from different geographical region (Subba Rao, 1989). Most of the studies have been done on the population, production ecology, diverse aquatic habitats and abundance of marine and non-marine gastropods (Khan and Chaudhuri 1984, Khade and Mane 2012, Sharma et al.2013, Senthamizhchelvi et al.2016) and also commercially important molluscs species (Baby et al, 2010). Saha et al. (2016) reported on Morphometrics, length-weight relationship and ecological factors affecting the habitat of *P. globosa* in Bangaledesh. But no one of investigated the length-weight relationship of gastropod in relation to habitat. Therefore an investigation was conducted to assessment the morphometric measurement analysis of *P. globosa* in various sites. This study is providing first baseline information on the aspects of the size and length-weight in different habitat of this species and also availability shell size at foraging selected site of Asian Openbill Stork in different habitat at Nagapattinam District, Tamilnadu, India.

2. Materials and Methods:

2.1 Study Area:

Sembanarkoil is a Panchayat Union in Tranquebar taluk in Nagapattinam district is plain and coastal in the Indian state of Tamil Nadu. It lies on the shores of the Bay of Bengal between 10°79' 06" N and 79°84'28" E. It is nearly 291 km south of Chennai. The town is located in the historic Thanjavur area on the banks of the river Cauvery. The Cauvery and its offshoots are the principal rivers. Agriculture is the main activity in this surrounding village as this is a cultivation rich land. Rice, black gram, Bengal gram, cotton, sugarcane and banana are such main products.

2.2 Sampling and Collection:

Collection of snails was done in where the foraging site selection by Asian Openbill Stork from October 2016 to September 2017 in five places and different habitat at Sembanarkoil region within the radius of 10km: Thalanchangadu, Mathur, Vallam, Arupathi and Karuvalakarai (Table-1). Animals were collected live specimen only by hand with the help of hand gloves from each the study site. In each site were five different habitats collected the specimen riverine, Irrigated canals, ponds, agriculture land and Marshes (Pramanik et al.2016). Collected the specimen in plastic bags and labeled the habitat type, site name, date, time and the record was maintained every month. The shells if deeply covered with mineral deposit and algae were cleaned by putting them in dilute solution of oxalic acid for few minutes before being scrubbed with a soft brush and washed in order to reveal operculum of shell. The specimens were put in 90% alcohol for 24 hours before removing the soft parts.

Table 1: Site Characteristic and location from Sembanarkoil region and keeping the four directions, Sembenarkoil as centre (within radius of 10 km) were studied during the study period from October 2016 September 2017.

S.No	Site Name	Latitude/ Longitude	Direction and Distance from Sembanarkoil	Site Characteristic
1.	Thalanchangadu	11° 13' 87.9"N 79° 78'70.3"E	North East Distance 8 km	Agriculture is the main occupation and paddy is the lone crop which is being cultivated
2.	Mathur	11°08'13.2" N 79°76'74.1" E	South East Distance 6 km	Agriculture is the main occupation. Paddy pulses, cereals and cotton plant are cultivated throughout year
3.	Vallam	11°09'02.2" N 79°74'98.5" E	South Distance 3 km	Agriculture is the main occupation and the predominant crop cultivated. Paddy Pulses and cereals cultivated
4.	Arupathy	11°10'04.2" N 79°73'29.7" E	South West Distance 4 km	Agriculture is the main occupation and the predominant crop cultivated. Pulses, cereals are crop which is being cultivated
5.	Karuvalakarai	11°13'86.1"N 79°71'93.6"E	North West Distance 7 km	Agriculture is the main occupation. Paddy Pulses, cereals and Banana cultivated

2.3 Morphometric Measurement:

Morphometric measurements were performed with the help of Vernier Caliper (Fig.-1) and live weight was recorded using electronic weigh balance. A total of 750 snails were used in the morphometric measurements at different sites and different habitat during the study period. Nine different measurements were taken the selected parameters and measurements were taken in centimeter (cm).

Figure 1: Shell size of *P.globosa* and measurement taken by using the Veriner Caliper (cm) during study period 2016-2017.

The shell length, shell width, aperture length, aperture width, height of spire, width of spire, shell thickness in millimeter (mm), total body wet weight and shell dry weight in grams (gm) Fig.-2. Relationship between the total length and total weight was investigated in different habitat and among the habitat. Age and seasonal of growth pattern varies hence the study was conducted throughout year.

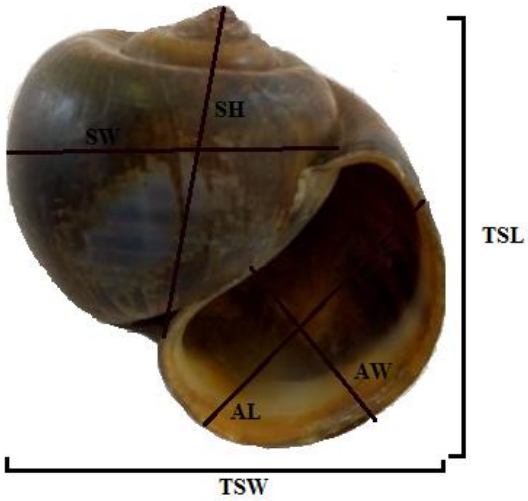


Figure 2: Measurements of shell morphology used in morphometric analysis of *P.globosa*. TSL= total shell length, TSW= Total Shell Weight, AL=Apertures Length, AW=Apertures Width, SH=Spire Height, SW=Spire Width.

2.4. Data Analysis:

The mean value of shell length and other variables were analyzed by using the MINITAB (17). One-way ANOVA test was used to test the differences between sites and among the habitat. T-test was used to test the differences in mean among the habitat. The Principal Components Analysis (PCA) was also made in order to consider character inter- correlations. The relationship between total shell length and total body weight was analyzed.

3. Results and Discussion:

3.1 Shell Length Variation Between the Sites:

Morphometric analysis of collected snails along with the thickness of shell and weight of shell was studied in between site and among the habitat. The shell length (3.56 ± 1.05 cm), shell width (2.90 ± 0.93 cm), Aperture length (2.59 ± 0.89 cm), Aperture width (1.39 ± 0.50 cm) and Shell thickness (1.33±0.66 mm) were observed. The total weight in wet condition and (33.14±11.86g) and total weight in dry condition (13.08±4.90g) were also recorded. The mean shell length of the populations varies was statically significant differ the between sites one-way ANOVA Table-2. The higher mean shell length of the populations 3.78±0.84 in Thalanchangadu and the lower mean shell length of populations 3.36±0.98 in karuvalakarai were recorded respectively. The mean of shell length was found 35.6 ± 1.05 mm the range of minimum 9 mm and maximum 60 mm shell length were recorded. The shell length of *P. globosa* has decreased compared with the values reported 20 years ago. Saha et al.(2016) reported that shell length of *P. globosa* 40.09 ± 16.08mm was recorded during 1995-1996 in Rajishahi University Campus, Bangladesh. These variations was reported in gastropods may be due to geographical (Irie 2006), temporal (Torroglosa and Giménez 2010) and environmental factors also key for variation of shell length in gastropods (Cazenave and Zanatta 2016).

Table 2**:** Summary of morphometric characteristic of *P.globosa* in the different sites and Sample size (N), mean± standard deviation of each variable given below during the study period 2016-2017.

S.No	Variables	Site Name						F*	P
		N	Thalanchan-gadu	Mathur	Vallam	Arupathy	Karuvala-karai		
1.	Shell Length (cm)	150	3.78 ±0.84	3.72±0.81	3.56±1.04	3.41±0.96	3.36±0.98	13.92	0.000
2.	Shell Width (cm)	150	3.09±0.81	3.14±0.78	2.91±0.99	2.77±0.97	2.61±0.96	14.87	0.000
3.	Aperture Length(cm)	150	2.75±0.80	2.82±0.72	2.614±0.92	2.42±0.96	2.33±0.93	15.03	0.000
4.	Aperture width(cm)	150	1.47±0.45	1.52±0.39	1.40±0.49	1.32±0.55	1.25±0.55	4.13	0.003
5.	Spire Height (cm)	150	1.70±0.81	1.70±0.76	1.62±0.90	1.50±0.92	1.30±0.85	5.24	0.000
6.	Spire Width (cm)	150	1.40±0.56	1.42±0.55	1.47±0.73	1.36±0.76	1.23±0.67	4.61	0.001
7.	Shell Thickness (mm)	150	0.15±0.06	0.14±0.07	0.14±0.08	0.12±0.09	0.12±0.09	4.88	0.001
8.	Body Wet Weight (gm)	150	35.5±11.6	35.7±10.5	34.6±12.6	31.4±11.5	30.0±11.3	56.41	0.000
9.	Body Dry Weight(gm)	150	14.46±4.39	14.0±3.9	13.5±5.02	12.04±5.0	11.67±5.1	10.87	0.000

F*= One Way ANOVA, Significantly at the P<0.05

3.2 Shell Length Variation among the Habitats:

Considerable variation was found in the mean of shell length of among the habitat (Table-3). The difference in mean shell length between the riverine habitat and agriculture habitat was highly significant (T-test 4.28, P< 0.001). The difference in mean shell length among the three habitats of riverine, irrigation canals and pond was not statistically significant (T-test 1.34 P< 0.08). Similarly, the mean shell length between the two habitats of marshes and agriculture habitat was not statistically significant (T-test 1.58, P< 0.06). Huq et al. 2002 was studied that feeding ecology of *P. globosa* in beel ecosystem the group of Shell length and body weight variation found that was differ availability of food item in the sites and 50-55 mm length group of *P. globosa* consumed the highest amount of food and also weight of alimentary canal observed in this group were maximum. The marine gastropod of *Littorina littorea* populations on rocky and sedimentary shores the biotic factors contribute differences in size structure were studied (Eschweiler et al.2008). Anam et al.(2016) reported that prey type and feeding techniques of Asian Openbill Stork in Assam India but size of prey and foraging success rate not reported therefore further study needed in relation to availability of prey size at non-foraging site of Asian Openbill Stork and also chosen by agriculture landscape how it is consumed the prey size since it is preferred by mainly prey on Pila species (Kahl.1971, Hancock et al.1993, Anam et al.2016).

Table 3: Summary of morphometric characteristic of *P.globosa* in the different habitat and Sample size (N), mean ± standard deviation of each variable given below during the st+udy period 2016-2017.

S.No	Variables	Habitat Type						F*	P
		N	Riverine	Irrigation canals	Ponds	Agriculture	Marshes		
1.	Shell Length (cm)	150	3.68±1013	3.77±0.95	3.82±0.83	3.17±0.88	3.37±0.87	3.72	0.00
2.	Shell Width (cm)	150	3.12 ± 0.92	3.06±0.93	3.15±0.88	2.52±0.90	2.68±0.83	6.55	0.00
3.	Aperture Length (cm)	150	2.76 ±0.85	2.71±0.88	2.86±0.86	2.23±0.86	2.37±0.81	5.98	0.00
4.	Aperture Width (cm)	150	1.41 ±0.41	1.41± 0.46	1.496±0.45	1.26±0.57	1.40±0.56	5.53	0.00
5.	Spire Height (cm)	150	1.46 ±0.77	1.53±0.86	1.728±0.76	1.37±0.92	1.73±0.95	5.40	0.00
6.	Spire Width (cm)	150	1.29 ±0.62	1.25±0.68	1.468±0.68	1.36±0.66	1.52±0.62	3.44	0.00
7.	Shell Thickness(mm)	150	0.14 ± 0.09	0.14±0.08	0.148±0.07	0.12±0.10	0.12±0.06	4.91	0.00
8.	Body Wet Weight (gm)	150	39.4 ± 10.4	36.1±11	38.76±9.82	23.6±8.9	29.37±10.0	6.83	0.00
9.	Body Dry Weight(gm)	150	14.2 ± 4.5	13.5±4.6	14.46±4.46	11.4±5.0	11.98±4.8	5.35	0.00

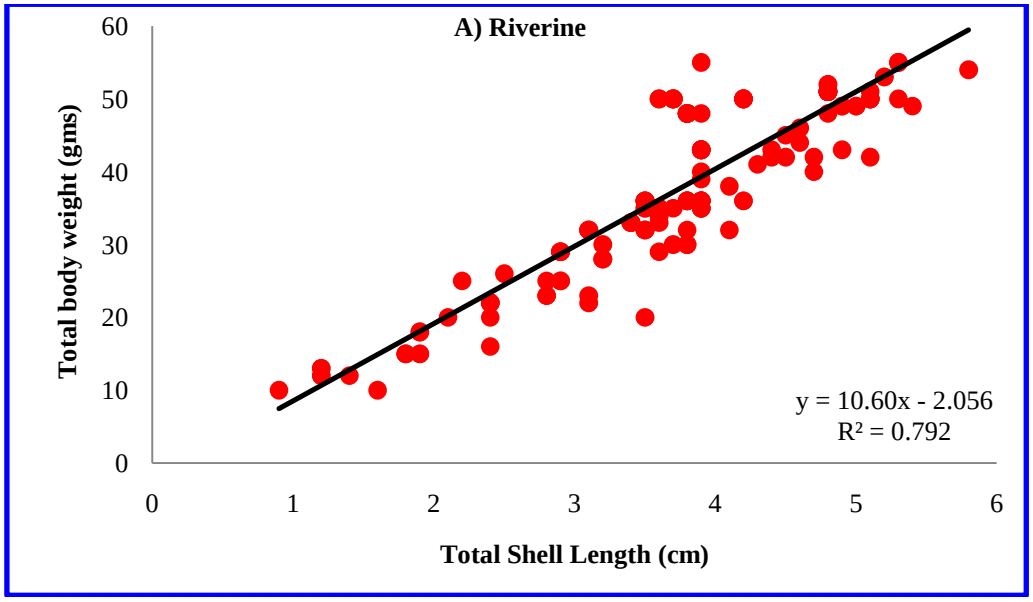
F*= One Way ANOVA, Significantly at the P<0.05

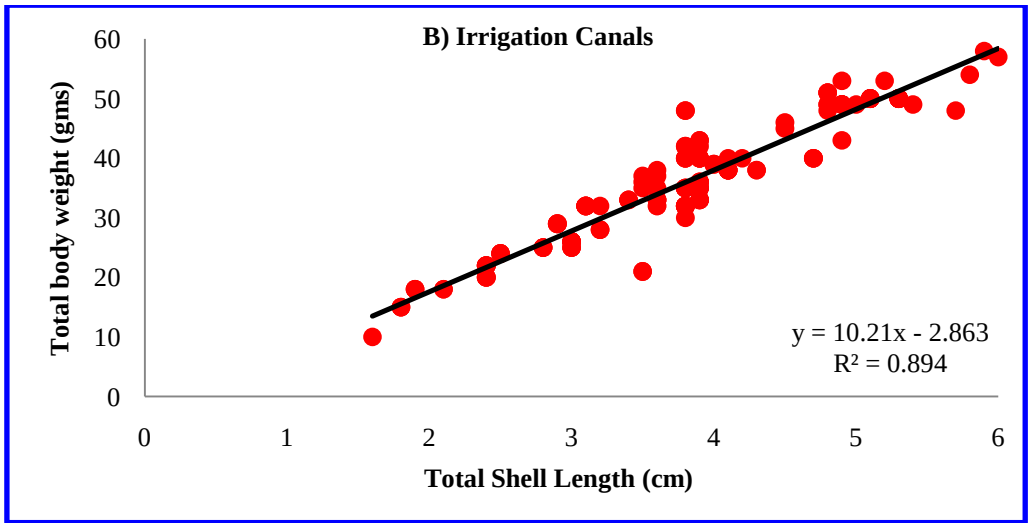
A Principal Components Analysis (PCA) was made in order to consider character inter-correlations. Eigen values and weights of the axes Principal Component I (PC I) to Principal Component V and each character are listed in Table-4. The first two axes (PC I and II) of the PCA represent 79.9% of the total variance; the first three axes (PC I to PC III) represent 86.8% of total variance of shell variation in morphometric

measurement of *P.globosa* . In accordance with the variance, only the first three axes were used for ordination. PC I is primarily an axis of shell length and therefore, in connection with shell width, shell weight , degree of aperture length and aperture width. PC II is mainly an axis of the intensity of the spire height and spire width and PC III is mainly an axis of the shell thickness.

Table 4: Factor loadings of traits in the Principal Component Analysis (PCA) of shell variation in morphometric measurement of *P.globosa*

Parameter	PC1	PC2	PC3	PC4	PC5
Shell Length	0.366	-0.177	-0.001	-0.019	-0.564
Shell Width	0.374	-0.179	-0.132	-0.017	-0.475
Aperture Length	0.376	-0.114	-0.146	-0.026	-0.063
Aperture Width	0.349	0.077	-0.366	0.182	0.349
Spire Height	0.295	0.499	-0.052	0.671	0.059
Spire Width	0.22	0.744	0.087	-0.616	-0.078
Shell Thickness	0.276	-0.05	0.896	0.171	0.070
Body Weight	0.342	-0.315	0.06	-0.3	0.498
Shell Weight	0.367	-0.115	-0.105	-0.129	0.261
Eigen Value	6.1883	1.0036	0.6197	0.3613	0.2504
Cumulative %	68.8	79.9	86.8	90.8	93.6





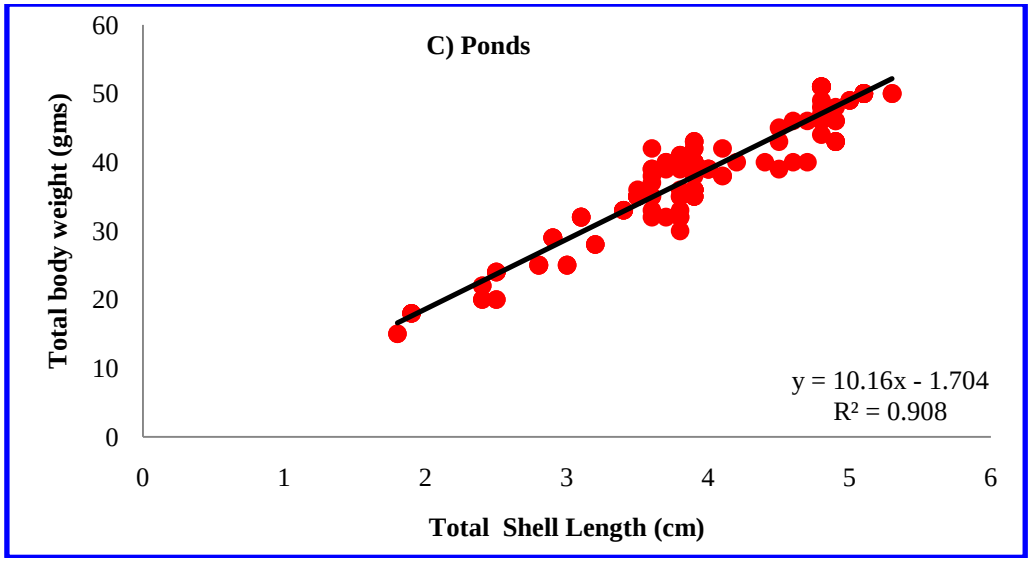
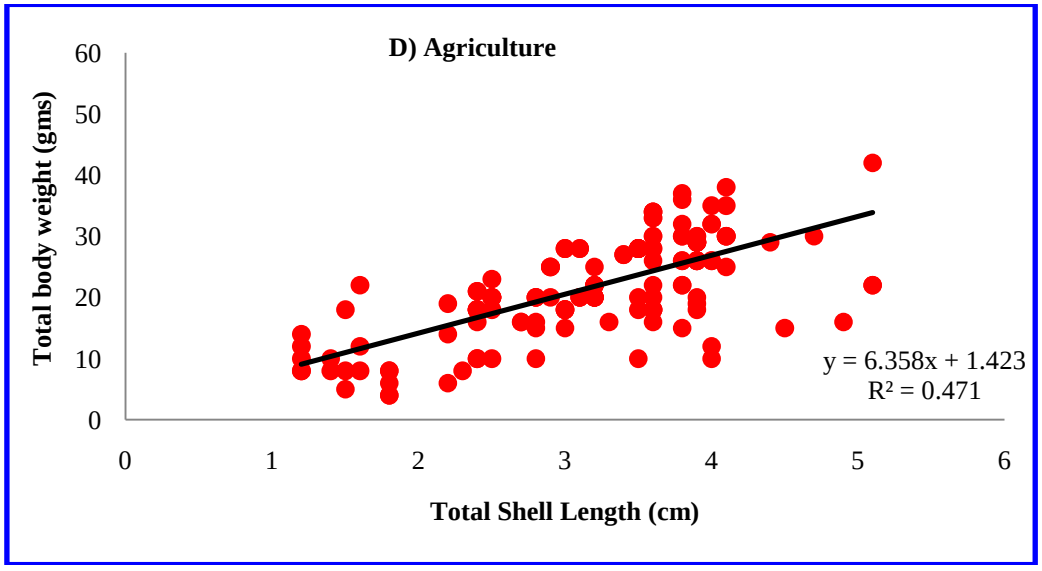
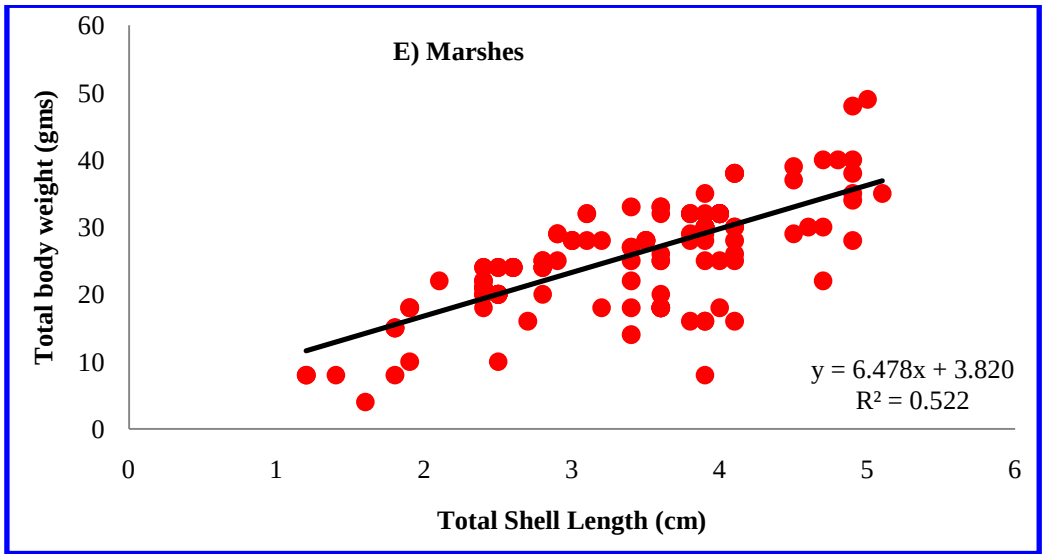


Figure 3a: Relationship between total shell length and total body weight of *P. globosa* in different habitats (A. Riverine, B. Irrigation Canals and C. Ponds) were observed the during study period 2016-2017.





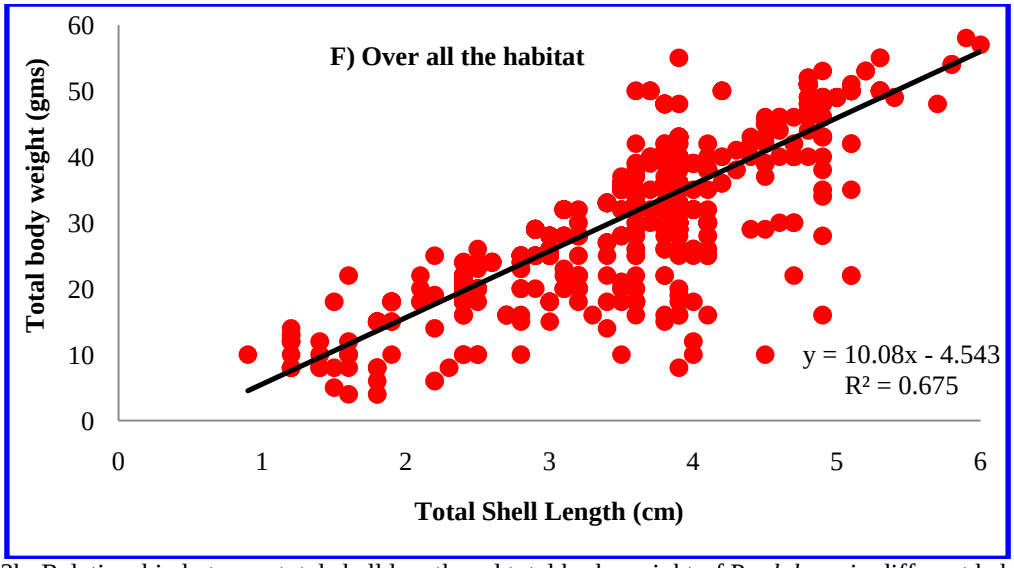


Figure 3b: Relationship between total shell length and total body weight of P. *globosa* in different habitat (D. Agriculture, E. Marshes and F. Overall the habitat) were observed the during study period 2016-2017.

3.3 Length-Weight Relationship:

The relationship between shell length and weight was found that allometric growth pattern in among the sites. Interesting was noticed that agriculture habitat low level of mean weight for *P. globosa* in compare with other habitat. The coefficient of correlation between length and weight measured separately for riverine, irrigation canals, ponds, agriculture and marshes habitat (Fig.-3a&3b). The allometric growth pattern was observed in *P. globosa* though habitat wise comparison was not done by Saha et al. (2016). Interesting that relationship between shell length and body weight of the riverine, pond and irrigation canal was higher relationship R^2=0.845 in compare with agriculture and marshes habitat was less relationship R^2= 0.491 observed respectively (Fig.-4). Variation was found among the habitat particularly in agriculture habitat received the length-weight pattern R^2 = 0.47 this reason for possibility of using of fertilizer, herbicides and pesticides may changing growth rate of gastropod (Mian and Mulla 1992). Although the availability of prey species occurred higher value at agriculture and marshes habitat particularly in monsoon and pre-monsoon period were recorded by Meganathan and Jeevanadham (2017). The study suggested that influence by amount received rainfall is major factor for availability of Pila Species and variation of length weight relation in relation to habitat because of using the chemical fertilizer. Agriculture land using by the bio-fertilizer and biological pest control will enriched the density of prey for bird species particularly the large wading bird like herons, egrets, storks, ibises etc,. It certainly leads to the rich avian diversity in agro-ecosystem since the avian species also help the pest control in agriculture field (Regmi 2003).

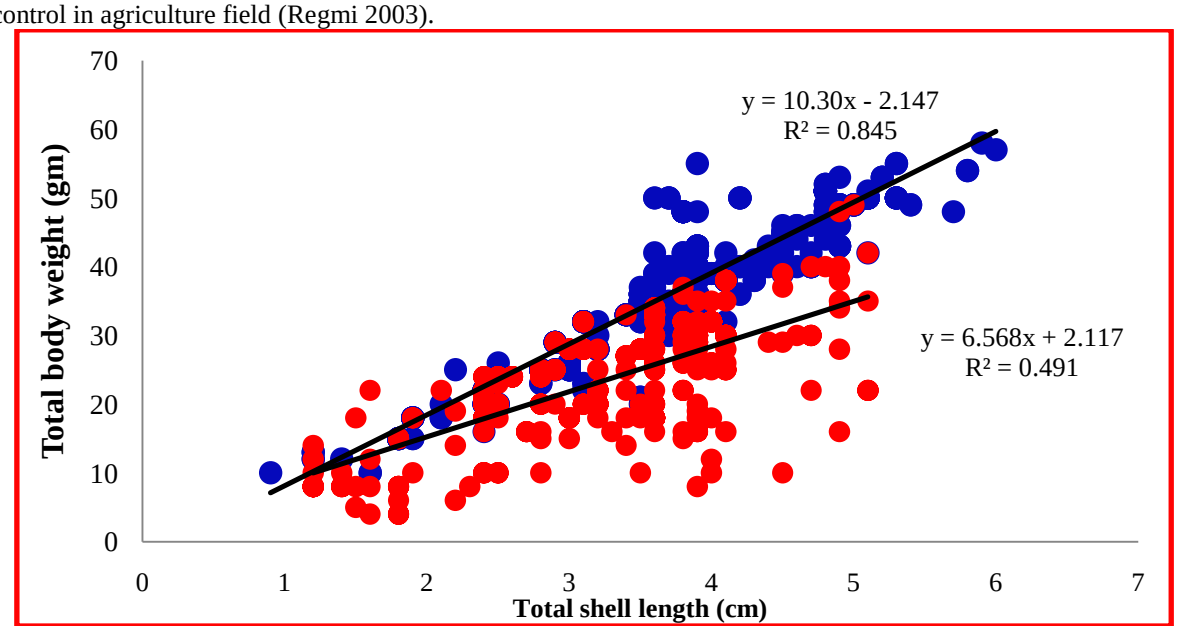


Figure 4: Relationship between total shell length and total body weight of *P. globosa* in Riverine, Irrigation canals, Ponds habitat (Blue colour circle R^2=0.845), Agriculture and Marshes habitat (Red colour circle R^2=0.491) were observed the during study period 2016-2017.

4. Conclusions:

Present study mainly focused at determining the morphometric study of Apple snail at foraging selected sites of Asian Openbill Stork. These study revel that variation was found among the habitats between sites. Apart from of these studies, no current information is available on size and length-weight relationship of *P. globosa in* different habitat. The further study needed for comparative studies on foraging site selection and non-foraging site and also chosen of prey size in agriculture habitat by Asian Openbill Stork.

5. Acknowledgement:

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