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Shell length study for a prediction of morphometric traits in freshwater snail *Lymnaea acuminata*

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Abstract
The present work emphasizes on the morphometric study of freshwater snail *Lymnaea acuminata* inhabitant of artificial ponds of the University campus, Aurangabad. Data was collected to evaluate correlation growth of phenotypic shell dimensions as a trait using multiple regression equation. The snail *Lymnaea acuminata* shell width (ASW), aperture length (ApL), aperture width (ApW) and total body weight (TLW), were the parameters predict the animal shell length ($Y=0.624+0.278X_1+0.337X_2-0.401X_3+0.992X_4$, $r^2=65.2\%$). The mean recorded for animal shell length, animal shell width, aperture length, aperture width and total live weight was 1.696±0.282cm, 2.466±0.353cm, 0.903±0.144cm, 0.499±0.080cm, 0.286 ± 0.124 gm respectively. The result showed correlation among morphometric traits of a single breed which indicated positive. It also showed strong and very high significant. Animal shell length and all body parameters are correlated and co-efficient.

Keywords: Prediction, morphometric traits, freshwater, *Lymnaea acuminata*

1. Introduction

The Genus *Lymnaea* snails, important members of freshwater ecosystems, inhabits the freshwater bodies that are situated in the range of sea level up to the height of 10,000 feet; even in icy water, hot springs and in shallow waters to the depth of 250 meters [7]. The freshwater Pulmonate snail, *Lymnaea acuminata* (Lamarck) belongs to family Lymnaeidae that prefers either permanent or temporary water bodies with abundant vegetation. The Lymnaeidae is a very common family of the freshwater snails, the body visceral mass is characteristically wound in a right handed helicoids spiral and is enclosed in a shell which is secreted by its covering epithelium, the mantle or pallium. These animals are with dextral as well as sinisterly shell patterns with tapering tentacles, tubular pneumostome and separate gonophores' at the base of the right tentacle. Snails are hermaphrodite and breed almost throughout the year and lay down eggs on the submerged surface of aquatic plants [19-6]. The highest rate of egg production being found during July to September, the juveniles measure about 0.2 cm in length (from apex of shell to margin of aperture) and adult snails about 3.0 cm. they are herbivorous feeding upon aquatic vegetation. The snail *Lymnaea acuminata* serves as intermediate host of some trematodes and other helminthes parasites which cause severe disease to domestic animals; they are serious agricultural and horticultural pest and also form an important link in aquatic food chains [6]. Snail *Lymnaea* In captivity lives for about 1. 5 to 3 years and sexually matures at an age of 2.5–3.5 months. Egg-laying slows down and may come to ceased in aged animals [10]. They mating unilaterally (i.e. each mating partner mates as either male or female) or in a sequential reciprocal manner in which the partners reverse sex roles after completing their first copulation cycle [31-13].

The species incorporated in Genus *Lymnaea* are pest to crops and ornamental plants. The detail morphological of shell gives insight about their actual body growth [25]. Reported morphometric was an application of multivariate statistical analyses of a set quantitative variables taken in to account viz length, width, and height of a shell. As the shell gradually grows in size there is addition of shell material at its margin to maintain its shape and at the coiling axis around which the aperture grows spirally; it is often an indicator point of shell growth [1]. In snail *Lymnaea* both dextral and sinistral forms are found in nature, with sinistral individuals representing up to 2% of the population [9]. In past only simple linear measurements i.e. shell length and shell width were considered for Malacological studies [23-24], but currently theoreticians have explored various models of shell measurement to understand the diversity of gastropods [29].

Lam P, Calow P [14]. Documented the direct current or flow of water has potential to change the shell morphology in the Pulmonate snail *Lymnaea*. Shells of Mollusk have been widely studied because of the possibility of describing the shell coiling with geometrical functions [27]. As molluscan shell size varies both intra-and inter species, the relative investment into shell and non-shell parts can change ontogenetically and within/between species [15]. Snails are among the few animals that provide a direct measurable connection to their individual lives, even after death, through their shell studies on morphology (i.e. size and shape) has been an important aspect in many biological fields paleontology, anatomy, ecology, systematic and to study phylogeny tree [26].

This study was therefore undertaken to obtain correlation coefficients of morphometric traits and in predicting animal shell length as morphometric trait of freshwater snail *L. acuminata* as well as to note the shell forms sinistral and dextral in a natural population.

2. Materials and methods

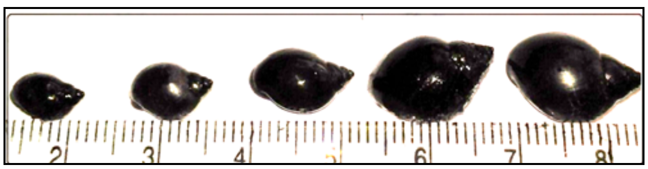

Fig 1: Figure showing the increasing size of snail *Lymnaea acuminata*

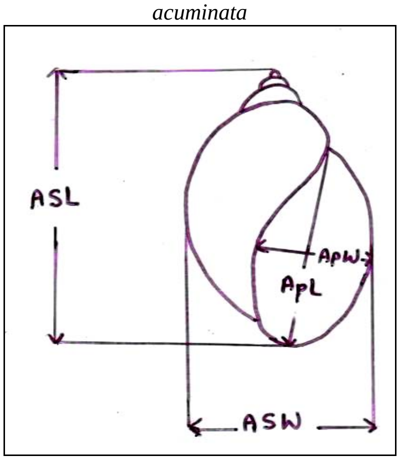

Fig 2: Morphometric traits of *Lymnaea acuminata* shell
Abbreviation: (ASL=animal shell length, ASW=animal shell width, ApL=aperture length, ApW=aperture width.)

Lymnaea acuminata were collected from the artificial ponds located in botanical garden of university campus Aurangabad, India at geographical Latitude 19 º54'9.58'' N, and Longitude 75 º18.42'' E. Sample collection was done in four month (June to September 2016) in monsoon season, preferably in morning time between 9:00am to 11:00 am. The samples were collected in the plastic bottles by 'hand- picking using hand gloves. After collection snails were brought to the laboratory, cleaned carefully with water and maintained in the plastic trough with aerator; they were fed with algae, Chara, and mulberry leaves. 200 snails were taken for the present study in range 1.0 cm to 2.9 cm and 0.10 g to 0.850 g length and weight respectively. Snails were selected on the basis of their active appearance, with no injury on the foot and no broken shell of the base population. Measurement data collected were (Fig. 2) animal shell length (ASL), animal shell width (ASW), aperture length (ApL), aperture width (ApW) and total body weight (TLW). As electric weigh balance was used to measure weights, while thread & cm scale was used to measure length and width (Fig. 1). The calculations of multiple regression function, Minitab 14 software and Excel 2007 was used to predict animal shell length from morphometric traits of the freshwater snail *L. acuminata*. The dextral and sinistral snails were identified on the shell shape like, (Left handed aperture opening) shell called as sinistral and (Right handed aperture opening) shell called as dextral. Mostly the *Lymnaea* species are dextral.

3. Results and discussion

The results were expressed as mean and standard deviation for each morphometric measurement (Table 1)

Table 1: Mean and standard deviation of morphometric traits in *L. acuminata* snail

Morphometric traits	Mean ± ($\bar{x}$)	standard deviation (SD)
Animal Shell length	1.696 ±	0.282
Animal shell width	2.466 ±	0.353
Aperture length	0.903 ±	0.144
Aperture width	0.499 ±	0.080
Total live weight	0.286 ±	0.124

Table 2: Correlation analysis of *L. acuminata*

Parameter	ASL	ASW	ApL	ApW	TLW
ASL	1				
ASW	0.757**	1			
ApL	0.671**	0.719**	1		
ApW	0.539**	0.644**	0.685**	1	
TLW	0.770**	0.827**	0.753**	0.715**	1

(**= Positive and highly significant)

The mean animal shell length was 1.696±0.282cm and the mean animal shell width was 2.466±0.353cm which is greater than the animal shell length, the mean aperture length was 0.903±0.144cm, and mean aperture width was 0.499±0.080cm which is less than the aperture length, the mean total live weight was 0.286 ± 0.124 gm, this results shows somewhat similar results with the work done by Afsan *et.al.* [12] i.e. the mean for *Lymnaea (p.) acuminata f. rufescens.* Shell height, shell width, aperture height, aperture width (15.24±0.32,7.66±0.18,11.05±0.25,6.24±0.20) and for *Lymnaea (p.) acuminata f. chlamys* (19.72±0.43,11.00±0.27,14.43±0.34,9.42±0.24) respectively. The results of phenotypic correlations among morphometric traits of snail *L. acuminata* evaluated (Table 2), indicated positive, strong and very high significant (p<0.01) correlation coefficient (rp) between animal shell length and all body parameters. Animal shell length showed positive, highly significant correlation with animal shell width (r=0.757), aperture length (r=0.671), aperture width (r=0.539) and total live weight (r=0.770) at 1% level (p<0.01). The animal shell width showed positive and high significant correlation with animal shell length (r=0.757), aperture length (r=0.719), aperture width (r=0.644), total live weight (r=0.827) at 1% level (p<0.01). Aperture length to animal shell length (r=0.671), animal shell width (r=0.719), aperture width (r=0.685), total live weight (r=0.753) is positively high significant correlation at 1% (p<0.01). Aperture width to animal shell length (r=0.539), animal shell width (r=0.644), aperture length (r=0.685) and total live weight (r=0.715).

Total live weight showed positively high significant correlation at 1% level ($p<0.01$) with animal shell length (r=0.770), animal shell width (r=0.827), aperture length (r=0.753) and aperture width (r=0.715). (Aluko *et.al.*) [5] Recorded the snail live weight is highly positive correlated with all body parameters. The prediction equation performed for animal shell length of growing snails, using morphometric traits from freshwater snail *Lymnaea acuminata* (Table.3). The multiple regression equation indicated that these morphometric traits, i.e. animal shell width, aperture length, aperture width and total live weight best predicted animal shell length. Olawoyin and Ogogo [20] reported shell length as a better predictor of body weight for growing snails. Okon *et.al.* [3] reported, using more than two morphometric traits in the prediction equation may give a better and more reliable results and recorded high percent. (Paul *et.al.*) [16] showed accurate predictions of width, height, foot weight and total weight (W = 0.773L, r^2 = 0.94), (H = 0.356L,r^2 = 0.73), (FW g = 7.28 x 10^{-4} $L^{2.47}$,r^2 = 0.71), (TW g = 2.15 x $10^{-3}L^{2.418}$, r^2 = 0.72) respectively, for *H. iris,* they conclude the morphometric variation in parameters is insufficient to encourage the development of alternative management strategies by shell width rather than the shell length. Similar studies were also undertaken for *Laevicaulis alte* from Odisha (Das and Parida) [2] they recorded a significant (at 1% level) positive correlation between the parameters length-live weight (0.943**), length circumference (0.898**), live weight-Circumference (0.823**),and was obtained linear Fitted regression equation considering three sets of morphometric variables i.e., length and circumference, live weight and circumference, length and live weight, (Y= 0.607x + 0.017, R^2 = 0.806), (Y= 0.536x + 1.671, R^2 = 0.678) and (Y= 0.998x – 2.307, R^2 = 0.888)) respectively.

Table 3: Prediction equation for animal shell length

Breed	Multiple regression equation ($Y=a+bx_1+x_2-x_3+x_4$)	R^2%	R^2(adj)%	R^2(pred)%
L. acuminata	$Y=0.624+0.278X_1+0.337X_2-0.401X_3+0.992X_4$	65.2%	64.5%	63.19%

Table 4: Coefficients of predictors

Predictor	Coef	SE Coef	T-value	P-value
Constant	0.6237	0.1344	4.64	0.000
ASW	0.27758	0.06216	4.47	0.000*
APL	0.3372	0.1365	2.47	0.014*
APW	-0.4007	0.2251	-1.78	0.077
TLW	0.9918	0.1973	5.03	0.000*

(*=significant at 5% ($p<0.05$))

Coefficients of determination (R^2%) of 88% and 84.7% for *A. marginata* and *A. fulica* respectively but for this study using multiple regression analysis, multiple morphometric traits (animal shell length, animal shell width, aperture length, aperture width and total live weight) from snail, the coefficient of determination (R^2%) of 65.2% obtained were significant, whereas in these results (Table. 4) the relationship between Animal Shell Length and Animal Shell Width, Aperture Length and Total Live Weight are statistically significant (because p-value for these term are less than the significance level of 0.05) at 5% ($p<0.05$). The relationship between animal shell length and aperture width is not statistically significant at 5% ($p>0.05$). Tokeshi *et. al.* [15] investigated the interspecific relationship between total weight and shell weight by plotting the mean shell weight and mean total weight of 10 largest individuals of each species (y=- 0.0597 + 1.009x, r^2= 0.997.), in their study they found all three possible relationships between the proportion of shell mass and body size, i.e. positive, negative and none, were recognized among molluscan species inhabiting the same shore environment, they conclude that in some species the proportion of shell mass increased with body size, while in others it either decreased or showed no change with size. The graph (Fig. 3) indicates that the error terms are approximately Normal, Thus our assumption of normality is valid. The coiling phenotype that is seen in the offspring is controlled by the genotype of the mother. In our observation we find that all *Lymnaea* snails were having dextral coiling of shell with 3-5 whorls. Identification has been done on the basis of shell shape i.e, (Left handed aperture opening) shell called as sinistral and (Right handed aperture opening) shell called as dextral. Mostly the *Lymnaea* species are dextrals with 3-5 whorls.

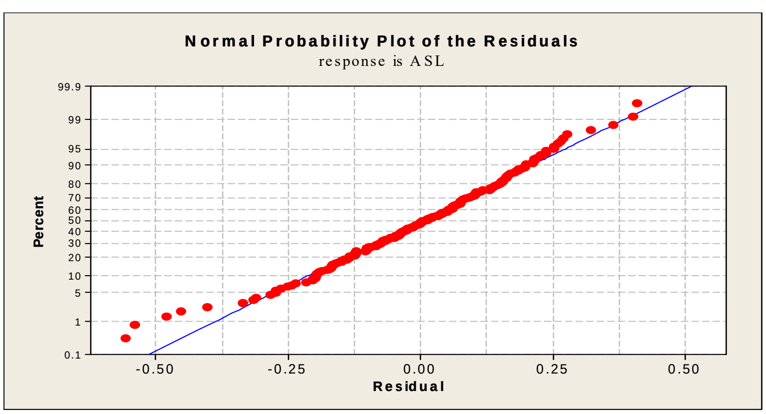

Fig 3: Normal probability plot of the residuals for animal shell length

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