RELATIONSHIP BETWEEN BASIC MORPHOMETRIC MEASUREMENTS AND CROSS CARCASS VARIATION IN THE BODY PARTS OF TRUNK FISH (*MORMYRUS RUME)* FROM AGAIE- LAPAI DAM, NIGER STATE, NIGERIA

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Abstract

A total of 91 Mormyrus rume specimen of various sizes were collected from Agaie – Lapai dam (Niger State) Nigeria, fourth nightly using gill nets, hook and line and cast nets, to evaluate the relationship between basic morphometric measurements, growth pattern, proximate composition of the whole body and cross carcass variation in its body parts using length weight relationship (LWR), condition factor (K) and laboratory analysis. The result of the basic biometric measurement of the specimens showed that Mormyrus rume from Agaie–Lapai dam had mean standard length of 34.08±3.28cm, total length of 37.71±3.57cm with a corresponding body weight ranges between 279.25-520g. The growth pattern analysis depicted that the fish was negative allometric with b value of 2.57 and condition factor "K" ranged from 0.73 – 1.21 with a mean value of 1.00±0.09. The results of the whole body proximate composition and cross carcass composition of its body parts showed that there was an inverse relationship between the body lipid and moisture in the whole body composition and that moisture was highest in the fish body in October and lowest in July while lipid was highest in June and lowest in October. Cross carcass variation of various parts of the fish showed that moisture ranged between 56.67-70.49 and was significantly higher in the fillet than other regions examined, the crude protein value ranged between 17.83-25.26% and the skin had the highest significant value, the lipid and ash ranged from 7.29-10.32% ;and the ash ranged from 2.02-6.40%, while the head region having the highest significant value in both the lipid and the ash values. It could be concluded that the M. rume of Agaie-Lapai depicted a strong significant correlation between the length and weight and the growth exponent "b" indicated a negative allometric growth pattern with a (K) value index above 1. Proximate analysis showed that the lipid and moisture were inversely proportional in the body of the fish while other nutrients in the body of the fish did not fluctuate significantly over time and nutrients were not evenly distributed among the body parts.

Key words: growth pattern, length- weight relationship, K value, cross carcass variation

Introduction

Length and weight data are useful standard results of fish sampling programs (Morato *et al.,* 2001). In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics (Erzini, 1994). Length-weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time-consuming in the field (Sinovcic *et al.,* 2004). One of the most commonly used analyses of fisheries data is length-weight relationship (Mendes *et al.,* 2004). The morphometric relationships between length and weight can be used to assess the well being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007). In addition, length-weight relationships are also important in fisheries management for comparative growth studies (Moutopoulos & Stergiou, 2002). Pauly (1993) stated that length-weight relationship (LWR) provides valuable information on the habitat

where the fish lives while Kulbicki *et al.* (2005) stressed the importance of LWR in modelling aquatic ecosystems.

The importance of fish and fisheries product in developing countries is on the increase. Foran *et al.* (2005) reported that fish is a highly proteinous food. Therefore, considering the nutritional benefits associated with fish consumption, it has become important that fish's mineral and proximate composition be assessed in order to establish the safety level of the table sized species before consumption. Furthermore, research has shown that fish is much more than just alternative source of animal protein. Fish oil is the richest source of fat that are essential for the normal brain development in unborn babies and infants. Health benefits of fish meat has been studied extensively and there are reports which confirm its preventive effects against cardiovascular diseases and some types of cancer, including colon, breast and prostate cancer (Rose & Connoll, 1993; Marchioli, 2001; Sidhu, 2003). These effects are largely attributable to the polyunsaturated fatty acids (PUFA) found in fish oils especially the n-3 family including the eicosapentaenoic acid (EPA or 20:5 n-3), the docosapentaenoic acid (DPA or 22:5 n-3) and the docosahexaenoic acid (DHA or 22:6 n-3) which are not synthesised in the human body but their inclusion in human diets is essential (Alasalvar *et al*., 2002). Most of these freshwater fish species are valuable sources of macro and micronutrients and play important roles in providing proteins and vitamins that are not commonly available in other foods. They are usually caught by a large number of subsistence fishermen and provide a major source of biochemical constituents to poor households. The variation in the chemical composition of fish is closely related to feed intake, migratory swimming and sexual changes in connection with spawning. Different types of food make proximate composition a bit different and also different part of the body makes the composition different as well. So it is essential to know the proximate composition of the fish to report their nutrient composition from the public health point of view.

Mormyrids or elephant snout fishes are curious looking fish, highly variable in shapes of their head and the extent of their unpaired fins. *Mormyrus rume* belong to the family Mormyridae and are found in freshwaters of tropical Africa (Meek, 1916; Greenwood *et al.,*1966). *Mormyrus rume* Valenciennes, 1846 are found in fresh waters of tropical Africa (Fawole, 2002). They occur in fast moving waters with demersal habits. Members of the family have rudimentary electric organs situated on each side of the terminal portion of the tail and they possess large brains (Olaoshebikan & Raji, 2004).

Dams are usually constructed in order to prevent floods, to supply drinking and domestic water, to generate energy and for irrigation purposes since the ancient times. The earliest dams were probably built for the purpose of irrigation, flood control and water supply. Most modern reservoirs are designed for two or more of these purposes. Usually the role of water storage reservoir is to impound water in periods of higher flows so that it may be released gradually during periods of lower flows, but sometimes the sole purpose of impoundment is to provide a new body of standing water for use. Example of such uses are for fishing or boating or for water-heat dissipation from a thermoelectric generating plant (Baxter, 2005).
Hence, sustainable management of the water, taking into account the economic, social and cultural development and the environmental impacts which came out as a result of the mentioned studies, has gained an increasing importance (Sait *et al,* 2006).

Human activities have fragmented and simplified the tropical wetland habitat. Resources enjoyed by the wetland communities are systematically being destroyed. Sustainable management and conservation of the wetland resources are urgently required. It has been established that information on the chemical composition of fish in respect to the nutritive

value is very essential to compare with other sources of animal protein, meat and poultry products.

Fish is a highly proteinous food consumed by the populace; a larger percentage of consumers eat fish because of its availability, distingused flavours and palatability, while fewer percentages do so because of its nutritional value. Therefore, studies on the proximate composition and mineral composition of the freshwater fishes need to be continously studied by fisheries researchers. However the consumer and fishery workers are left with limited or little of information on the importance of particular fish species in their daily diets (Adewoye *et al.,* 2003). Few reports on the nutritive values of *Mormyrus rume* exist, and there is lack of information about basic morphometric measurement and proximate composition of different body parts of *Mormyrus rume* found in man-made dams in the North Central Zone of Nigeria. So it is in this view that this study was carried out, to evaluate the relationship between some basic morphometric measurements and cross carcass variation in the body parts of *Mormyrus rume* from Agaie-Lapai dam.

Materials and Method

Sampling area

Agaie – Lapai dam is located at the boundary between Lapai and Agaie Local Government Areas of Niger state, hence the name Agaie-lapai dam. It is a man-made earth fill dam across river Jatau at Bakajeba with a reservoir capacity of $147x10^6$ cubic meters. The dam is of rolled heterogeneous embankment type with a crest length of 1193.87 m, maximum height of about 16 m and about 38 mm^3 capacities. It also has part of its components about 750 m Spill channel with 3 m free board. Accessibility is through a 2.5 km-untarred road, which Tees off on the right of Paiko-Lapai tarred road. The dam is about 23 km away from Paiko. It lies to the North-East of Lapai town and East of Bakajeba town. The dam is geographically located at latitude $9^0$14 North of the Equator and longitude $6^0$30 East of Greenwich. The major source of the dam is River Jatau, which is a tributary of River Kaduna. The main purpose of establishing the dam was to get water for Abuja metropolis and also to supply water for irrigation in Agaie, Lapai and its environs. The dam site as a typical tropical climate characteristic seasonal changes: rainy and dry seasons. The rainy season is usually from April to October, having its peak within the month of August and September while the dry season covers the remaining months of November to March. Maximum and minimum mean temperature is between 28.33^0C and 38.89^0C and 19.44^0C and 26.67^0C, respectively. Before the construction of the dam, the major occupation of the people was farming and fishing around the dam site.

Fish sampling and Measurement

Specimens of *Mormyrus rume* were collected from the fishermen at two sampling sites twice a month for seven months from April, 2012 to October, 2012. Gill nets of mesh sizes 50-55 mm were used by the fishermen. A total of 91 fishes were collected at the sampling site. Specimens collected were kept chilled in an ice chest to avoid post mortem damage. The fishes were washed, kept in the ice chest and quickly taken to the laboratory. At the laboratory, total length (TL) was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Standard length (SL) was measured from the tip of the snout to the caudal peduncle. Other basic morphometric features; snout length, head length, fork length and eye diameter were measured using a metre rule and a mathematical set divider. The lengths were taken with metre rule to the nearest 0.1cm. Body weight of individual fish was measured to the nearest 0.1g using the sensitive weighing balance after removing the water and other particles from the body surface. Linear regression was employed to evaluate the relationship between the measurements.

Growth Pattern and Condition Factor

Linear regression was employed to determine the type of relationship between any given pairs of variables and their linear equation. Correlation analysis was used to ascertain the significance of this relationship; a derivative of length weight study is the ponderal index denoted as:

The length-weight relationship (LWR) was expressed by the equation:

$$\text{Log weight} = \text{Log } a + b \text{ Log length}$$

Where W =weight (g) L= standard length (cm)
Where a and b are regression constants.
The condition factor was calculated using the Formular:
$K = [100\ W] / L^3$
Where K = condition factor, L = standard length (cm) and W =weight (g).

Proximate Composition Analyses

After preparation of edible parts of fish as described, proximate composition analyses were performed according to Association of Official Analytical Chemists (AOAC) procedures (AOAC, 2000). Water content was determined by drying samples at 105±2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content (AOAC, 2000).

Statistical Analyses

Data collected were analyzed using one – way analysis of variance (ANOVA) using Statistica 6.0 (Stat-Soft, Inc., USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

Results

The result of biometrics of *Mormyrus rume* specimens are presented in Table 1. Standard length of the specimens ranged from 28.5-39 cm with a corresponding body weight ranging from 279.25-520g and a total length ranging from 31.3-43.75cm. Snout length ranged from 0.6-0.8cm with a mean standard deviation of 0.67±0.05, while the head length ranged between 5.6-8.4cm with a mean standard deviation of 7.27±0.77.

Relationship between the Morphometric Measurements

Standard length – head length relationship: When the head length was regressed against the standard length in figure 1, it was observed that there was a strong positive relationship between the head length and the standard length, as correlation co-efficient (r) was 0.81 and was significant ($P<0.05$). This indicates that a proportional increase in the standard length can be associated with an increase in the head length.

Body weight – head length relationship: Figure 2 shows the regression of the head length against the body weight; it was observed that there was a strong positive relationship between the head length and the body weight as correlation co-efficient (r) was 0.77 and was significant ($P<0.05$). This indicates that a proportional increase in the body weight can be associated with an increase in the head length.

Standard length – snout length relationship: Figure 3 shows the regression of the snout length against the standard length. It was observed that there was a significant relationship between the snout length and the standard length as correlation co-efficient (r)

was 0.82 and significant (P<0.05). This means that a proportional increase in the standard length was associated with an increase in snout length.

Body weight- snout length relationship: Snout length was regressed against the body weight as shown in figure 4 it was observed that there was a significant relationship between the snout length and the standard length as correlation co-efficient r was 0.88 and significant (P<0.05). This means that a proportional increase in the standard length was associated with an increase in snout length.

Standard Length – body weight relationship, condition factor and growth pattern: Figure 5 shows the regression of standard length against the body weight. It was observed that there was a strong positive relationship between the standard length and the body weight, as correlation coefficient (r) was 0.95 and was significant (P<0.05). This means that an increase in standard length was associated with an increase in body weight. It was also observed that the growth pattern indices of *Mormyrus rume* from Agaie - Lapai dam was negatively allometric with b value of 2.56. The condition factor of *Mormyrus rume* from Agaie - Lapai dam is shown in Table 2 and it ranged from 0.73 – 1.21 with a mean value of 1.00±0.09.

Proximate composition and Carcass variation of the body parts

Whole body composition: The result of the seasonal proximate composition of whole *Mormyrus rume* specimens from Agaie- Lapai dam examined is shown in Table 3. There was a significant seasonal variation in the lipid and moisture values of the specimens. Lipid from the samples collected ranged from 7.14±0.34 to 9.86±0.42% and was significantly highest in July and lowest in April (P<0.05), while the moisture content of the samples ranged between 66.47±2.35 and 69.66±3.21 and was significantly highest in October and lowest in July (P<0.05). The crude protein did not vary considerably over time, the samples value ranged between 16.37±1.48 and16.47±1.25 hence, there was no significant differece in the crude protein of the fish between April to October in all the samples analysed (P>0.05) and the ash content ranged between 3.44±0.37 and 3.75±0.22 but there was no significant difference in the ash content of the samples throughout the period of the study (P>0.05).

The results of the proximate composition of some of the body parts of *Mormyrus rume* samples is shown in Table 4.The skin had the highest value in both moisture and crude protein and was significantly (P<0.05) higher than the other body parts examined (73.13±0.55 and 25.26±0.39) while the head region had the lowest moisture content and crude protein (56.67±0.14 and 17.83±0.20) and was significantly (P<0.05) lower than other body parts measured. The head region had the highest lipid content (10.32±0.45) however it was not significantly different from that of the fillet but was significantly different from that of the skin. The head region also had the highest significant value in the ash content (6.40±0.24) while the fillet had the lowest significant ash content (2.02±0.05).

Discussion

From the result of the basic morphometric measurement of the 91 *Mormyrus rume* specimens examined, it was observed that the fish have the ability to grow averagely big, hence can be regarded as a fast growing fish. Biometric analysis of the body parts shows the following; when the snout length was regressed against the standard length, there was a positive correlation and the correlation was significant. Hence it was observed that an increase in the length of the fish also leads to a proportionate increase in the snout length. The head length also showed a strong positive correlation when regressed against the standard length; hence an increase in the length was associated with an increase with head

length. From the above analysis, it could be said that any increase in size could be associated to all parts of the fish body. There was a strong positive linear relationship between the head length and the body weight. This implies that for any increase in weight, there is also a proportional increase in the head length. This agrees with the theory of proportionality of growth of organism as stated by Mosby (2009) and Bake and Sadiku (2012).

Data analysis of the length-weight relationship gave useful information concerning the growth pattern and well being of the fish. Zafar *et al.* (2003) reported that fish weight is considered to be a function of length. Growth was described as the change in the absolute weight (energy content) or length of fish over time (Wooten, 1998), while Sadiku (1994), Bake and Sadiku (2012) summarized growth as a function of size. Wooten reported that fish grow in length as well as in bulk. Linear regression of log standard length and log weight gave useful co-efficient. Regression "b"= 3 is isometric; below this is negative allometric and above it is positive allometric (Tesch, 1978). Fagbenro *et al.* (1991) stated that obedience to the cube law (isometric growth, b = 3) is rare in a majority of fishes especially freshwater fishes. This was found to be the case with *M. rume* in this study; which showed a deviation from the cube law. The growth of *Mormyrus rume* from Agaie – Lapai dam was negatively allometric with "b" value of 2.56. This implies that the length growth rate is faster than the body weight growth rate. This result is similar to the findings of Odedeyi *et.al* (2007) from Ose River.

Samat *et al.,* (2008) and Abowei (2009) reported that the suitability of an aquatic habitat for fish growth is determined by the value of the condition factor. This study showed that the condition factor of *Mormyrus rume* from Agaie - Lapai dam ranges from 0.73 – 1.21 with a mean value of 1.00±0.09. This result is similar to the findings of Oben *et al.* (1999) on *M. rume* in Lekki Lagoon and Odedeyi *et al*. from Ose River, hence in this study the condition factor of *Mormyrus rume* from Agaie – Lapai dam indicated that the fishes were is a good condition and well being.

The proximate composition of *Mormyrus rume* (protein, lipid, moisture and ash) were considered in evaluating the nutritional value of the specie studied. The proximate composition of *Mormyrus rume* varies considerably between April- October. Stansby (1985); Azim *et.al* (2012) reported that variation in proximate composition of fresh fish may vary with species variation, season, age and feeding habit of the fish. The result of the present study shows that there was fluctuation in moisture and lipid value of whole *Mormyrus rume* from April-October, this variation in moisture and lipid content of the samples showed that with a gradual decline in moisture content, fat content gradually increased, this result agrees with the previous works reported on freshwater fisheries by Sadiku and Oladimeji (1991); Bake and Sadiku (2012); Bake *et al* (2014). Huss 1995; Love, 1997; Saoud, *et al*., (2007), also reported that fat content has shown inverse proportionality to water content in some semi fatty fish species muscle, this may be attributed to the seasonal differences in availability of food and changes in the reproductive cycle having considerable effect on the tissue biochemistry of the fish particularly changes in the lipid and water content of there body system.

The nutritional elements showed variable values in the various body regions measured. From this study the skin had the highest significant value in the crude protein, this may likely be as a result of some digestable and undigestable properties of protein attributed to the skin of fishes Choi and Regenstein (2000). Gudmunsson and Hafsteinsson (1997) and Choi and Regenstein (2000) reported that the fish skin is a potential source of phosporus, gelatin, melanin and keratin. the high concentration ash content in the head region can be

attributed to the concentration of inorganic materials present in the head region, this agrees with the report of Steffens (2006) who stated that the head region of a fish is mostly bones whis are very rich in inorganic materials.

In conclusion, this study shows that there is a proportionate growth and a positive relationship between the basic morphometrics parts of the fish measured, the high condition factor of the fish also reflect a good physiological state and the well beign of the fish. The growth pattern of *Mormyrus rume* from Agaie-Lapai dam is negatively allometric, which is the normal growth pattern of the fish. The proximate composition of the fish shows that the fish is rich in protein hence can be a very source of protein to the rural populace and the is a fatty fish because of its high lipid content. Further studies need be carried out on the other properties and compositions of the fish.

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Table 1: Summary of biometric measurements of *M.rume* sample from Agaie-Lapai dam, Niger State

Measurements	Range (cm)	mean value
Total length (cm)	31.55-43.75	37.71±3.57
Standard length(cm)	28.5-39	34.08±3.28
Body weight (g)	279.25-520	386.41±79.83
Snout length (cm)	0.6-0.8	0.67±0.05
Head length (cm)	5.6-8.4	7.27±0.77
Eye diameter (cm)	0.7-1.3	1.16±0.15
Fork length(cm)	2.6-4.75	3.63±0.73

Table 2: Summary of condition factor 'K' value of *M.rume* sample from Agaie-Lapai dam, Niger State

Measurement	Range(cm)	Mean value
k value	0.73-1.21	1.00±0.09

Table 3: Summary of the whole body of proximate composition of *M. rume* sample from Agaie-Lapai dam, Niger State

Months	Moisture (%)	Lipid (%)	Protein (%)	Ash (%)	Crude fiber (%)
April	68.17±2.13^{b}	7.14±0.34^{b}	16.41±1.32	4.36±0.08	1.18±0.14
May	67.36±2.16^{c}	7.56±0.22^{b}	16.44±1.03	4.31±0.12	1.21±0.12
Jun	67.44±1.13^{c}	9.57±0.31^{a}	16.45±0.45	4.35±0.24	1.22±0.24
Jul	66.47±2.35^{d}	9.86±0.42^{a}	16.47±1.25	4.30±0.05	1.19±0.05
Aug	66.55±2.46^{d}	9.75±1.02^{a}	16.43±2.05	4.32±0.56	1.20±0.56
Sept	68.74±1.32^{b}	8.98±1.21^{c}	16.38±1.45	4.31±0.62	1.23±0.62
Oct	69.66±3.21^{a}	8.23±1.32^{c}	16.37±1.48	4.32±0.31	1.19±0.31

Table 4: Summary of Proximate composition of various body parts of *M. rume* sample from Agaie-Lapai dam, Niger State

Body component	Head region	Fillet	Skin
Moisture	56.67±0.41^{c}	70.49±0.49^{b}	73.14±0.55^{a}
Crude protein	17.83±0.20^{c}	20.95±0.69^{b}	25.26±0.39^{a}
Lipid	10.32±0.45^{a}	9.15±0.34^{ab}	7.29±1.29^{c}
Ash	6.40±0.01^{a}	2.02±0.05^{c}	3.06±0.02^{b}

*1 Values in the same row with different superscript letters are significantly different ($p<0.05$) from each other ($n=3$).

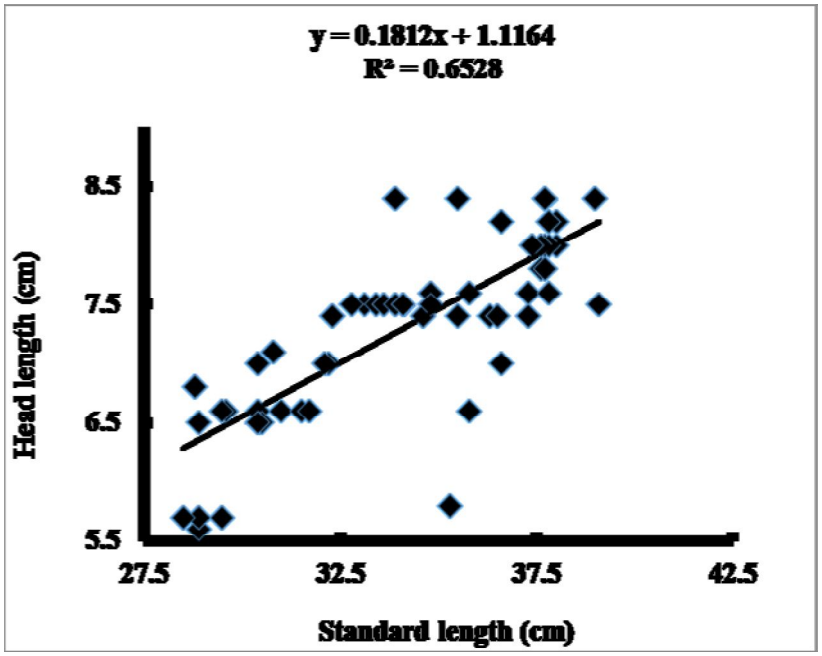

Figure 1: Standard length-head length relationship

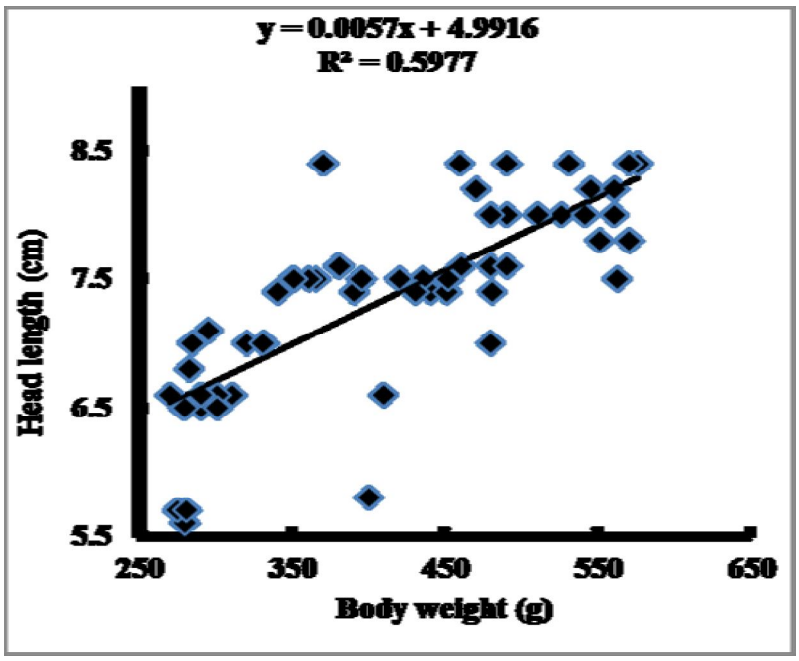

Figure 2: Body weight-head length relationship

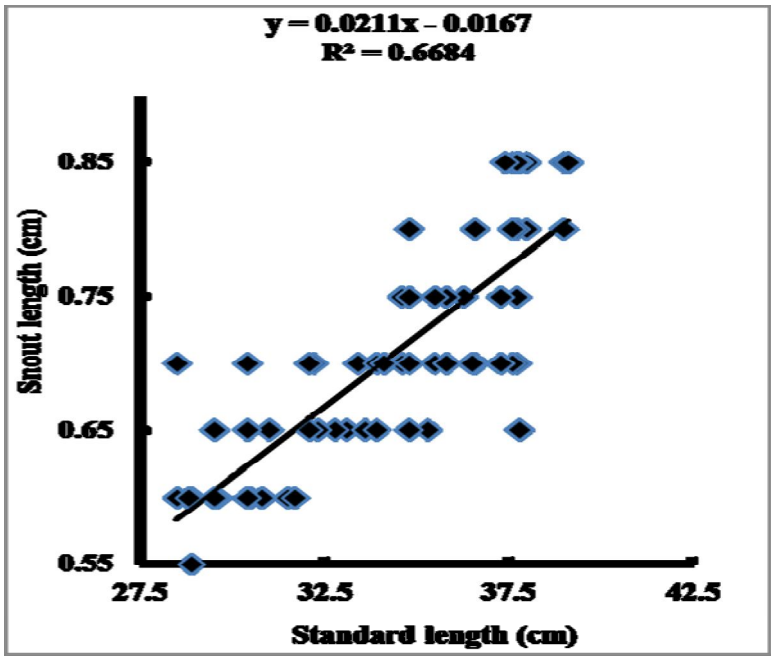

Figure 3: Standard length -snout length relationship

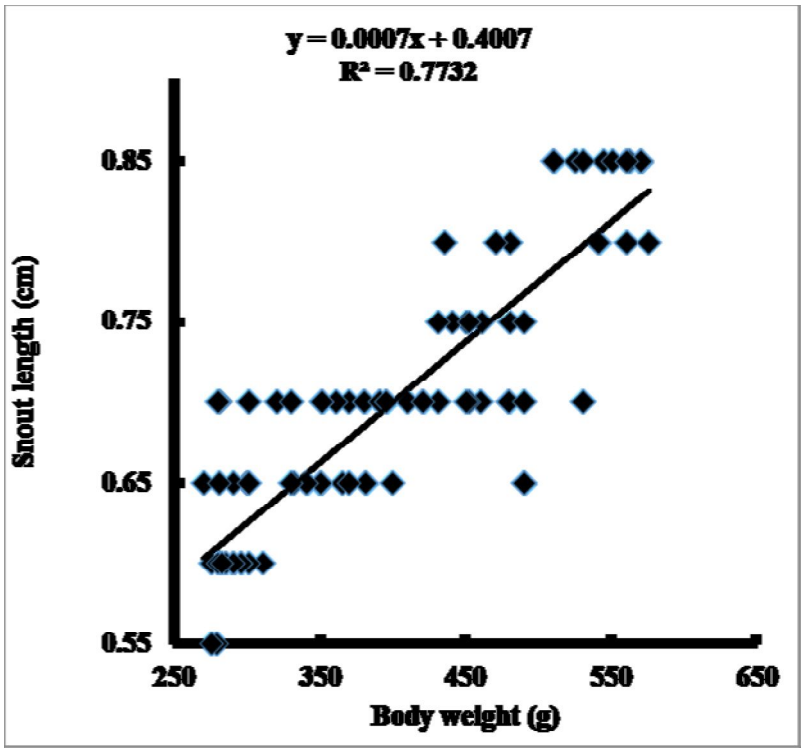

Figure 4: Body weight-snout length relationship

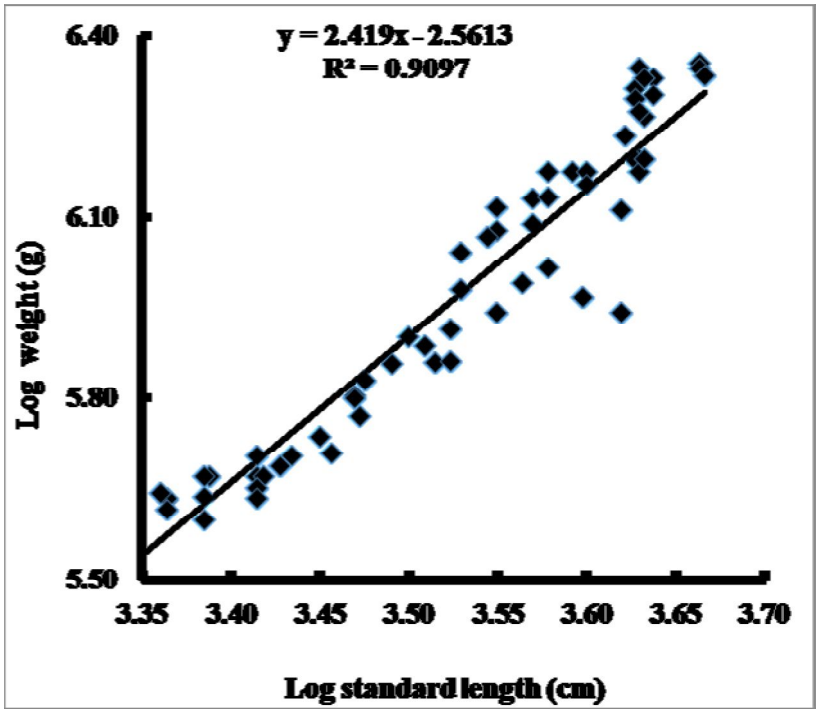

Figure 5: Standard length – Body weight relationship