Some Biometric Parameters of Four Selected Fish Species in Doma Dam, Nasarawa State, Nigeria

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1 Introduction

The knowledge of fish biology particularly biometric parameter is of utmost important not only to fill up the lacuna of our present day academic knowledge but also to increasing the technological efficiencies of the fishery entrepreneurs for evolving judicious pisciculture management (Swain & Foote, 1999). Fish morphology is inseparably related to study of the mode of life and the analysis of size and shape variations becomes fundamental to highlights variability in living organisms (Turan et al., 2004).

Morphological parameters and biometrical characteristics including morphometric measurement and meristic count have been used to identify fish stocks and remain the simplest and most direct way among methods of species identification (Turan et al., 2004). The study of differences and variability in morphometric and meristic characters of fish stocks is important in phylogenetics as it provide information for subsequent studies on the genetic improvement of stocks. To our knowledge this is the first of such study which is aimed at evaluating the biometric parameters and annual variations in condition factor of commercially important fishes such as Hydrocynus breves, Alestes dentex, Hydrocynus forskali, and Blycinus leuciscus from doma dam.

2 Materials and Methods

2.1 Description of study area

The study area is Doma Dam in Doma Local Government Area of Nasarawa State Nigeria, Doma Dam was constructed for the purpose of irrigation which was co-ordinate by the Lower Basin Authority (LRBA) it cover an area of 3,975km². It’s maximum surface normally occurs during rainy seasons of July – September there after it recedes so that minimum level is reached just before the start of rains in June.

2.2 Sample collection and measurement

Four species of fish from doma dam were selected for this study, namely Hydrocynus breves, Alestes dentex, Hydrocynus forskai, and B. leuciscus. The fishes were obtained from artisanal fishermen landing site in the dam. The fishermen used different types of fishing gears both passive and active fishing gears, which include traps, seine, cast net, gill nets, clay nets, hook and lines and crafts. Sample were collected for a year starting July 2014 to June 2015.
During each collection, samples were ice check and moved to the College of Agriculture Lafia, in the Fisheries Department Laboratory for analysis. Total length (cm) and other morphometric measurement were taken using meter rule while weight (g) was gotten using the sensitive weighing balance. Biometrical parameters recorded includes six morphometric measurement and seven meristic counts as determined and described by Samaradivakara et al. (2012). The morphometric variables standard length, weight, body depth, pre-dorsal distance, eye diameter, caudal fin length. The meristic counts pectoral fin ray, pelvic fin ray, dorsal fin ray, anal fin ray, Pore lateral line scale, Upper teeth rows, Lower teeth rows

2.3 Statistical analysis
To ensure that variations in this study were only attributed to body shape differences, and not to the relative sizes of the fish, size effects from the data set were eliminated, by standardizing the morphometric parameters using the allometric formula given by Elliott et al. (1995):

\[ M_{adj} = M (Ls / Lo)^b \]

Where M = original measurement, \( M_{adj} = \) size-adjusted measurement, Lo = TL of the fish, Ls = overall mean of the TL for all specimens.

Parameter b was estimated for each character from the observed data as the slope of the regression of log M on log Lo, using all fish in all groups. However, it has been established that meristic characters are independent of size of fish hence should not change during growth (Strauss, 1985; Murta, 2000) therefore the raw data were analysed without transformation as described above. Statistical analyses in the present study included descriptive statistics using Minitab 14 as well as univariate analysis of variance using Genstat ® discovery edition IV. Where significant differences occurred, Duncan’s least significant difference was used to separate the mean values of morphometric and meristic parameters. Morphometric and meristic data were subjected to discriminant function analysis (DFA) using Genstat ® discovery edition IV.

3 Results
Table 1 compares the morphometric measurements of the four fish species in the study. Result reveals that A. dentex had significantly higher standard length (20.88) than H. breves and H. foskali (19.11 and 18.84 respectively) however least value was recorded in B. leuciscus. Similarly Mean weight of A. dentex was higher (119.40) compared to H. foskali (96.93), H. breves (94.60) and B. leuciscus (14.24). Similarly Predorsal distance was higher in A. dentex (9.08), followed by H. foskali and H. breves (8.09 and 6.54 respectively), with the lowest value recorded in B. leuciscus (2.57). Mean eye diameter of H. foskali was higher (8.74) than other species while B. leuciscus recorded the lowest (0.41). Mean pectoral fin ray in H. foskali and A. dentex was 12 in number and higher than the number observed for B. leuciscus and H. breves (11 and 9 respectively), similarly, pelvic fin ray was highest in H. foskali (13) and lowest in A. dentex and B. leuciscus (9). Mean dorsal fin ray of A. dentex and H. breves was 10 in number and higher than 8numbers recorded in B. leuciscus and H. foskali. Anal fin ray was higher in H. breves (22) and lowest in H. foskali (9). Result also reveal caudal fin ray to be much in H. breves (23) and least in H. foskali (12). Pore lateral line scales however, were higher in H. foskali (6) and lower in A. dentex (3), there was no difference in the lower teeth rows of the fish species however 3 row of upper jaw was observed in H. breves as against 2 rows observed for the other species.

Relationships of the morphometric measurement and meristic count analysis among the selected fish species from doma dam was considered according to the 1st and 2nd discriminant function (DF) (Figures 1 for morphometric parameters and Figure 2 for meristic count). The 1st DF accounted for 76% and the 2nd DF accounted for 12% of among-group variability of the morphometric data, and together they explained 88% of total among-group variability. On the other hand, the 1st and 2nd DF of the meristic count analysis accounted for 75% and 16% respectively of the among-group variability; together they explained 91% of total among-group variability. According to the canonical discriminant function coefficients obtained for the morphometric data, the most influential morphometric variables using the 1st DF were the predorsal distance, body depth, standard length and eye diameter, while anal fin ray, caudal fin ray and pelvic fin ray constituted the most influential meristic variable for discrimination of the groups. Plots of canonical discriminant functions 1 of the morphometric measurements (Fig. 1) clearly showed a complete overlap between H. breves and H. foskali and a partial overlap with A. dentex and separate however from B. leuciscus.
Table 1 Mean Morphometric Measurements And Meristic Counts of Selected Fish Species from Doma Dam

| Parameters            | Alestes dentex | Brycinus leuciscus | Hydrocynus breves | Hydrocynus foskali | P-value |
|-----------------------|----------------|--------------------|-------------------|-------------------|---------|
| Standard length       | 20.88 ± 0.59a | 5.89 ± 0.08c       | 19.11 ± 0.37a     | 18.84 ± 0.25a     | 0.001   |
| Weight                | 119.40 ± 7.81a| 14.24 ± 0.19c      | 94.60 ± 3.62b     | 96.93 ± 3.03b     | 0.001   |
| Body depth            | 9.64 ± 0.41a  | 3.53 ± 0.04c       | 4.73 ± 0.13b      | 4.70 ± 0.12b      | 0.001   |
| Pre-dorsal distance   | 9.08 ± 0.63a  | 2.57 ± 0.03d       | 6.54 ± 0.59a      | 8.09 ± 0.15b      | 0.001   |
| Eye diameter          | 3.36 ± 0.39b  | 0.41 ± 0.02d       | 2.21 ± 0.23c      | 8.74 ± 0.24a      | 0.001   |
| Pectoral fin ray      | 12.40 ± 0.05a | 11.09 ± 0.08b      | 9.35 ± 0.36c      | 12.39 ± 0.04a     | 0.001   |
| Pelvic fin ray        | 9.00 ± 0.00b  | 9.00 ± 0.00b       | 8.67 ± 0.10a      | 12.78 ± 0.05b     | 0.001   |
| Dorsal fin ray        | 10.00 ± 0.00a | 7.78 ± 0.05c       | 10.26 ± 0.47a     | 8.37 ± 0.04b      | 0.001   |
| Anal fin ray          | 19.47 ± 0.00b | 13.12 ± 0.11c      | 22.05 ± 0.85a     | 9.01 ± 0.05d      | 0.001   |
| Caudal fin ray        | 22.37 ± 0.22ab| 22.22 ± 0.14b      | 23.21 ± 0.80a     | 12.23 ± 0.09b     | 0.001   |
| Pored lateral line    | 2.82 ± 0.06c  | 4.22 ± 0.06c       | 5.16 ± 0.36b      | 5.76 ± 0.03a      | 0.001   |
| Upper teeth rows      | 2.00 ± 0.00b  | 2.00 ± 0.00b       | 3.07 ± 0.30a      | 2.03 ± 0.04b      | 0.001   |
| Lower teeth rows      | 2.00 ± 0.00   | 2.00 ± 0.00        | 2.00 ± 0.00       | 1.00 ± 0.00       | 0.243   |

Mean in the same column with different superscript differ significantly (P<0.05)

Figure 1 Discriminant Function Scores Based On Morphometric Measurements for the Selected Fish Species from Doma Dam

Figure 2 Discriminant Function Scores Based On Meristic Count for the Selected Fish Species From Doma Dam

Plots of canonical discriminant functions 1 for meristic count as shown in Fig. 2 however shows overlap of *A. dentex*, *B. leuciscus* and *H. breves* and completely separated from *H. foskali*.

4 Discussions

Fish has been said to demonstrate greater variances in morphological traits both within and between populations of species than any other vertebrates (Allemand et al. 1987, Winberger 1992). This study recorded significant differences in among morphometric parameters of the four fish species considered from Doma dam. Beacham (1985), Beacham & Murray (1985), Beacham & Withler (1985), Beacham et al. (1988), Lund et al. (1989) and Kinnison et al. (1998) had earlier stated that variation in morphometric parameters of fish is largely due to factors such as geographical and habitat variation or differences in genetic component based on differences among groups in a common environment. Solomon et al., (2015) further suggested genetic variation caused by inbreeding, crossbreeding and other practices leading to dilution of gene pool as the major cause of differences in cultured and wild species of African catfish. However the marked differences of morphology in the present study may be linked to genetic differences of the species. Reported morphological parameters of the species in this study as given by [www.fishbase.org](http://www.fishbase.org) Paugy (2003) and Paugy (1990) are in line with the results of the present study. More so this study can serve as a useful reference material for some parameters (such as caudal fin ray, pectoral fin rays, spine number and lent of most fins etc.) not reported in the previous study but measured in this study. The
monthly variation in morphological data observed in this study are likely due to age difference of captured fish at every month, environmental condition prevalence as it affect the susceptibility of different age group for capture, and the physiological state of the captured fish.

According to the canonical discriminant function coefficients obtained for the morphometric data for the different species, the most influential morphometric variables using the 1st DF were the predorsal distance, body depth, standard length and eye diameter, while anal fin ray, caudal fin ray and pelvic fin ray constituted the most influential meristic variable for discrimination of the groups. Samaradivakara et al. (2012) had earlier reported standard length, body height and pre-dorsal distance as major contributors to canonical discriminant function 1 in morphometric parameters of four Tilapia Populations in Selected Reservoirs of Sri Lanka. However, Haddon & Willis (1995) stated that Morphometrics of the head and body depth have been regarded as the most important characters for discrimination of angler fish (Lophius vormerinus), Pacific herring (Clupea pallasi) and Orange roughy (Hoplostethus atlanticus) (Leslie & Grant, 1990; Schwegert, 1990; Haddon & Willis 1995) while Turan et al., (2005) reported HL as the only

| MONTHS  | H. BREVIS  | A. DENTEX | B. LEUCISCUS | H. FOSKALI | P-value |
|---------|------------|------------|--------------|------------|---------|
| January | 1.86<sup>a</sup> | 1.63<sup>b</sup> | 7.61<sup>a</sup> | 1.38<sup>c</sup> | 0.01 |
| February | 0.92<sup>d</sup> | 4.32<sup>b</sup> | 6.29<sup>a</sup> | 1.63<sup>c</sup> | 0.01 |
| March   | 1.11<sup>c</sup> | 2.45<sup>b</sup> | 3.92<sup>a</sup> | 1.34<sup>c</sup> | 0.01 |
| April   | 1.09<sup>c</sup> | 1.23<sup>c</sup> | 6.86<sup>a</sup> | 3.12<sup>b</sup> | 0.03 |
| May     | 1.14<sup>c</sup> | 1.39<sup>c</sup> | 15.35<sup>a</sup> | 2.63<sup>b</sup> | 0.02 |
| June    | 1.66<sup>c</sup> | 2.01<sup>b</sup> | 14.21<sup>a</sup> | 1.52<sup>c</sup> | 0.01 |
| July    | 0.66<sup>c</sup> | 1.34<sup>b</sup> | 13.52<sup>a</sup> | 1.38<sup>b</sup> | 0.05 |
| August  | 3.51<sup>b</sup> | 0.82<sup>d</sup> | 13.85<sup>a</sup> | 1.50<sup>c</sup> | 0.03 |
| September | 2.22<sup>c</sup> | 3.48<sup>b</sup> | 6.11<sup>a</sup> | 1.24<sup>d</sup> | 0.01 |
| October | 1.35<sup>c</sup> | 1.65<sup>b</sup> | 14.64<sup>a</sup> | 1.35<sup>c</sup> | 0.01 |
| November | 1.19<sup>c</sup> | 0.75<sup>d</sup> | 10.42<sup>a</sup> | 1.34<sup>b</sup> | 0.05 |
| December | 1.94<sup>c</sup> | 2.53<sup>b</sup> | 9.17<sup>a</sup> | 1.37<sup>d</sup> | 0.05 |

Mean in the same column with different superscript differ significantly (P<0.05)

| Months   | H. breves  | A. dentex | B. leuciscus | H. foskali | P-value |
|----------|------------|------------|--------------|------------|---------|
| January  | 19.73 ± 0.32<sup>ab</sup> | 20.01 ± 2.29<sup>a</sup> | 5.76 ± 0.12<sup>c</sup> | 19.09 ± 0.60<sup>b</sup> | 0.001 |
| February | 20.35 ± 0.25<sup>a</sup> | 16.70 ± 1.67<sup>b</sup> | 6.59 ± 0.17<sup>c</sup> | 17.74 ± 0.84<sup>b</sup> | 0.001 |
| March    | 18.27 ± 1.25<sup>c</sup> | 20.59 ± 2.22<sup>a</sup> | 7.35 ± 0.17<sup>d</sup> | 19.21 ± 0.61<sup>b</sup> | 0.001 |
| April    | 17.00 ± 0.00<sup>b</sup> | 22.70 ± 1.22<sup>a</sup> | 6.39 ± 0.19<sup>c</sup> | 16.85 ± 1.26<sup>b</sup> | 0.020 |
| May      | 23.23 ± 1.13<sup>a</sup> | 20.64 ± 1.96<sup>b</sup> | 5.16 ± 0.26<sup>d</sup> | 16.25 ± 0.70<sup>c</sup> | 0.030 |
| June     | 20.18 ± 0.12<sup>b</sup> | 22.38 ± 1.83<sup>a</sup> | 6.46 ± 0.35<sup>d</sup> | 18.27 ± 0.70<sup>c</sup> | 0.020 |
| July     | 20.50 ± 0.29<sup>a</sup> | 20.63 ± 2.29<sup>a</sup> | 4.94 ± 0.31<sup>c</sup> | 19.73 ± 0.57<sup>b</sup> | 0.050 |
| August   | 19.25 ± 0.75<sup>b</sup> | 24.49 ± 1.36<sup>c</sup> | 5.00 ± 0.33<sup>c</sup> | 19.66 ± 0.69<sup>b</sup> | 0.012 |
| September | 17.00 ± 1.15<sup>b</sup> | 19.55 ± 2.32<sup>a</sup> | 6.36 ± 0.23<sup>c</sup> | 20.49 ± 0.57<sup>a</sup> | 0.034 |
| October  | 20.00 ± 0.41<sup>b</sup> | 21.01 ± 2.66<sup>a</sup> | 5.34 ± 0.28<sup>d</sup> | 19.57 ± 0.67<sup>c</sup> | 0.012 |
| November | 16.00 ± 2.08<sup>c</sup> | 25.10 ± 1.96<sup>a</sup> | 5.75 ± 0.25<sup>d</sup> | 20.71 ± 1.33<sup>b</sup> | 0.002 |
| December | 18.05 ± 1.59<sup>ab</sup> | 17.27 ± 1.39<sup>b</sup> | 5.97 ± 0.28<sup>c</sup> | 18.48 ± 0.89<sup>a</sup> | 0.012 |
| Total    | 19.11 ± 0.37<sup>b</sup> | 20.88 ± 0.59<sup>a</sup> | 5.89 ± 0.08<sup>c</sup> | 18.84 ± 0.25<sup>b</sup> | 0.01 |

Mean in the same column with different superscript differ significantly (P<0.05)
important parameter for discrimination of six population of African catfish in Turkey. Eyo (2003) reported that among four *Clarias species* (*Clarias ebriensis, C. albopunctatus, C. gariepinus* and *C. anguillaris*), congeneric differences occurred in pectoral fin base length and frontal width, pelvic fin base length, Pectoral spine height, dorsal fin height, maxillary teeth band width, premaxillary teeth band depth, frontal, fontanelle length, internasal space, pelvic fin-anal fin space and prenasal barbell length, and in 6 residual characters namely Total Length, prepectoral length, pectoral fin base length, length, dorsal fin base length, outer mandibular barbel space and eye diameter. Specific differences among Distichodus species studied by Nwani and Ude, (2005) reveals that pelvic fin height, dorsal fin height, anal fin height, pectoral-pelvic fin space, pelvic anal fin space, head length and caudal peduncle depth were of significant taxonomic importance in discriminating all the studied Distichodus species. Nevertheless, in general, fishes demonstrate greater variance in morphological traits both within the same species or different species or between populations than other vertebrates and reflect differences in feeding environment and habit, prey types, food availability or other features (Dunham et al., 1979; Allendorf, 1988; Thompson, 1991; Wimberger, 1992). It is also important to note that Among the principal morphological variables that aid in the discrimination this species and populations, some are related to feeding habits while the others are to swimming capacity and maintenance of the fish in the water column.

Plots of canonical discriminant functions 1 of the morphometric measurements in this study clearly showed a complete overlap between *H. brevis* and *H. foskali* and a partial overlap with *A. dentex* and separate however from *B. leuciscus*. However, plots of canonical discriminant functions 1 for meristic count shows overlap of *A. dentex, B. leuciscus* and *H. brevis* and completely separated from *H. foskali*. Overlapping variation in morphometric characters lead to great difficulty in identifying different stocks. Jerry and Cairns (1998) indicated that phenotype of an individual is a manifestation of its underlying genotype, as expressed in the local environment during development. Consequently, individuals of different species that develop and mature in the environment or area would be expected to share a similar phenotype, as they are likely to experience common environmental and genetic influences (Chambers, 1993). Hence the noticeable overlap among different species for morphometric and meristic count in this study might be explained by this. Vidalis et al. (1994) had argued that meristic characters may follow a predetermined variability at a very narrow range, and divergence of the meristic counts from a standard

| Months     | *H. Brevis* | *A. dentex* | *B. leuciscus* | *H. foskali* | P-value |
|------------|-------------|-------------|---------------|--------------|---------|
| January    | 103.67 ± 6.84<sup>a</sup> | 100.00 ± 29.50<sup>b</sup> | 13.41 ± 0.53<sup>c</sup> | 86.25 ± 4.21<sup>b</sup> | 0.031   |
| February   | 100.50 ± 4.50<sup>b</sup> | 130.00 ± 14.90<sup>a</sup> | 15.86 ± 0.59<sup>a</sup> | 88.55 ± 9.76<sup>b</sup> | 0.001   |
| March      | 107.50 ± 2.50<sup>b</sup> | 126.70 ± 24.10<sup>a</sup> | 14.41 ± 0.45<sup>c</sup> | 89.90 ± 6.48<sup>b</sup> | 0.001   |
| April      | 91.25 ± 1.25<sup>b</sup> | 143.8 ± 21.20<sup>a</sup> | 13.36 ± 0.62<sup>c</sup> | 130.00 ± 20.50<sup>a</sup> | 0.001   |
| May        | 110.00 ± 10.00<sup>a</sup> | 86.30 ± 13.10<sup>b</sup> | 16.59 ± 0.69<sup>b</sup> | 98.10 ± 11.60<sup>b</sup> | 0.021   |
| June       | 90.00 ± 17.30<sup>b</sup> | 224.80 ± 44.20<sup>a</sup> | 18.64 ± 0.33<sup>c</sup> | 83.25 ± 5.77<sup>b</sup> | 0.003   |
| July       | 93.30 ± 16.70<sup>a</sup> | 96.60 ± 19.70<sup>a</sup> | 10.00 ± 0.00<sup>b</sup> | 96.80 ± 5.60<sup>a</sup> | 0.001   |
| August     | 80.00 ± 10.60<sup>b</sup> | 113.80 ± 21.00<sup>a</sup> | 12.14 ± 0.49<sup>c</sup> | 99.50 ± 7.10<sup>b</sup> | 0.002   |
| September  | 83.30 ± 16.70<sup>a</sup> | 106.50 ± 24.40<sup>a</sup> | 12.82 ± 0.49<sup>d</sup> | 99.50 ± 8.14<sup>b</sup> | 0.001   |
| October    | 52.50 ± 1.44<sup>b</sup> | 95.00 ± 32.3<sup>b</sup> | 15.23 ± 0.25<sup>b</sup> | 93.50 ± 8.47<sup>a</sup> | 0.002   |
| November   | 120.00 ± 0.00<sup>a</sup> | 87.00 ± 10.20<sup>b</sup> | 13.91 ± 0.42<sup>b</sup> | 117.50 ± 16.60<sup>a</sup> | 0.021   |
| December   | 112.50 ± 7.50<sup>c</sup> | 114.10 ± 20.10<sup>a</sup> | 14.50 ± 0.35<sup>c</sup> | 80.60 ± 7.42<sup>b</sup> | 0.002   |
| Weight     | 119.40 ± 7.81<sup>c</sup> | 14.24 ± 0.19<sup>c</sup> | 94.60 ± 3.62<sup>b</sup> | 96.93 ± 3.005<sup>b</sup> | 0.01    |

Mean in the same column with different superscript differ significantly (P<0.05)
range could be fatal for the individual. Several authors have also considered meristic characters as less useful than the morphometric data (Misra & Carscadden, 1987) when comparing morphological variations. Furthermore, studies on meristic characters of horse mackerel (Mutra, 2000), shrimp (Munasinghe & Thushari, 2010) were less informative, when compared with the morphometric ones however, this study have shown that there were overlaps and complete separations in different species as observed in this study. Generally the observable overlap among species despite genetic differences may have been as a result of similar species adaptations in response to the prevailing environmental conditions as earlier stated.

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