REVALIDATING THE BIOMETRIC CHARACTERS OF NILE TILAPIA *OREOCHROMIS NILOTICUS* (LINNAEUS, 1758) IN MEIKTILA

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Abstract

Nile tilapia *Oreochromis niloticus* was carried out to assign the classification of local population relation to their biometric parameters. A total of 265 samples were collected from five markets in Meiktila. Biometric characters of eleven meristic counts and seventeen morphometric traits were generated with Principal Component Analysis (PCA). The result shows the meristic characters of *O.niloticus* did not change with any increasing in relation to variable morphometric parameters. Analysis of variance (PCA) revealed the two components with 86.85 % (λ=14.76) at Taw Ma market, 86.43 % (λ=14.69) at Wun Zin market, 84.67 % (λ=14.39) at Pauk Chaung market, 83.44 % (λ=14.18) at Myo Thit market and three components with 80.66 % (λ=13.71) at Myo Ma Central market. Coefficient determination R^2 revealed variable significant relationships in total length and other body parts among population, however, with head length relationship showed low correlation in interorbital width (IOW) and mouth length (ML) in all markets. The most striking pattern of hybrid tilapia was found in Pauk Chaung market and Myo Thit market. These pilot surveys strongly suggest the local population of non-indigenous Nile tilapia *O.niloticus* with the existence of morphological differentiations among population. In addition, the pure population of tilapia species is urgently needed to maintain without hybridizing with other species in Meiktila Environs.

Keywords: Nile tilapia, meristic, morphometric, biometric, growth

Introduction

The origin of Nile tilapia (Cichlid) species is in East Africa (EA), which includes three economically important genera *Tilapia*, *Oreochromis*, and *Sarotherodon.* In aquaculture, the correct identification of species frequently requires based on the features of meristic counts employing traditional morphometric (TM) by using linear measurements of the fish anatomical parts of the body (Trewavas, 1983). Morphometric characters have been commonly used in fisheries biology as powerful tools which are helpful in easy and correct classification of fish species and their performance and morphological traits are used to estimate the economic output by fish farmers (Marengoni *et al.,* 2015). Recently, the genetic improvement of tilapias will be accelerated by using contemporary molecular techniques (Yue *et al.*, 2016).

Tilapia species play a main role in supplement of protein resources that demand on the requirement of local population. Therefore, the original source of tilapia species must be maintained with different culture systems (either ponds or lakes or dams) as well as in natural habitat for long term sustainable development. The successful management of fisheries resource produces the good quality of fish shape that reflects on the interest of aquaculturists, researchers and consumers. In Myanmar, aquaculture is the second sectors of economic income so every species is necessary for sustainable development without changing their intrinsic (e.g. habitat heterogeneity) and extrinsic factors (e.g. dispersal capability, mating system and habitat preference).

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According to Myanmar Fisheries resources, tilapia species were introduced from Thai and Israel since 1975. Due to exploitation of breeding success, tilapia species are widely distributed throughout Myanmar, especially in rural areas. The Myanmar Aquaculture-Agriculture Survey (MAAS) has implemented in May 2016 to provide the national fish supply and study the technical and economic incomes. In order to correct identification of tilapia species in Myanmar, it is urgently needed to evaluate the non-indigenous species of Nile tilapia in Meiktila environs. The present study was conducted to confirm the species status of the genus *Oreochromis niloticus* in Meiktila, using diagnostic morphological characteristics among population.

Materials and methods

Study area and site

Meiktila lies between the 20° 53′ 29.96″ N and 95° 56′ 18.51″ E, at elevation 244 meters above sea level. Samples were collected from Pauk Chaung market, Myo Ma Central market, Wun Zin market, Taw Ma market, and Myo Thit market.

Source: Google 2019

Figure 1 Map showing sampling sites at Meiktila.

Study period

The present study was conducted from August 2018 to March 2019.

Sample collection and biometric characters

Fifty samples from Pauk Chaung market, 55 from Myo Ma Central market, 50 from Wun Zin market, 44 from Taw Ma market, and 66 from Myo Thit market were collected for studying their biometric characters. All collected specimens were brought to Laboratory, Department of Zoology for further analysis. Eleven meristic counts were recorded from each fish such as dorsal fin spine (DFs) and rays (DFr), pectoral fin (PF), pelvic fin spine (PcFs) and rays(PcFr), anal fin spine (AFs) and rays (AFr), caudal fin (CF), scale along lateral line (SLL), scale below lateral (SBLL), scale above lateral line (SALL), scale before dorsal fin (SBDF), branchiostegal rays (BR) and first lower gill rackers (FLGR), respectively. Digital photograph was taken on the left side of each specimen. Seventeen morphometric characters were measured from each labeling fish with designated landmark points (Plate 1). Morphological characters were measured with Image J (1.51j8) in nearest 0.01 cm.

Plate 1 Landmark points of Nile tilapia *Oreochromis niloticus* for morphometric measurements.

AB – total length (TL), AC – standard length (SL), AD – predorsal length (PrDL), DB – postdorsal length (PoDL), AE – head length (HL), AF – snout length (SnL), FG – eye diameter (ED), HI – dorsal fin length (DFL), JK – anal fin length (AFL), LM – pelvic fin length (PcFL), NO – pectoral fin length (PlFL), CB – caudal fin length (CFL), PQ – caudal peduncle length (CL), RS – caudal peduncle depth (CD) and TL – height of the body (HB).

Length-length relationship (LLR)

Twelve morphometric characters such as standard length (SL), predorsal length (PrDL), postdorsal length (PoDL), head length (HL), dorsal fin length (DFL), anal fin length (AFL), pelvic fin length (PcFL), pectoral fin length (PlFL), caudal fin length (CFL), caudal peduncle length (CL), caudal peduncle depth (CD) and height of the body (HB) were expressed as a percentage of the total length (TL). Four morphometric characters such as snout length (SnL), eye diameter (ED), interorbital width (IOW) and mouth length (ML) were also presented as a percentage of the head length (HL). According to Froese (2006), the growth performance of length-length relationship was determined as follows : $\text{Log}\,\text{L} = \text{Log}\,\text{a} + \text{b}\,\text{Log}\,\text{TL}$, where TL is total length (mm) and L is length of body parts (mm).

Sample identification

The species of Nile tilapia *Oreochromis niloticus* were identified following Trewavas (1983), Eccles (1992), Skelton (1993) and Al-Faisal and Mutlak (2014).

Statistical analysis

Observed data were presented as descriptive statistics, correlation coefficient, and the morphometric measurements were used by the principal component analysis (PCA) generated the loading components using SPSS ver.21.

Results

The non-indigenous populations of 265 Nile tilapia *Oreochromis niloticus* from five markets in Meiktila were investigated for verification of their biometric characters. Comparative studies on eleven meristic counts of Nile tilapia; they were not largely changed among populations. The mean values of meristic counts were presented in Table 1. In which pectoral fin rays, pelvic fin spine and rays, and anal fin spies and rays of tilapia species were fixed.

Table 1 Descriptive statistics of meristic counts on Nile tilapia *Oreochromis niloticus* from five markets in Meiktila

Meristics	Pauk Chaung market (N=50)		Wun Zin market (N=50)		Myo Ma market (N=55)		Taw Ma market (N=44)		Myo Thit market (N=66)	
	Mean ±	S.D	Mean ±	S.D	Mean ±	S.D	Mean ±	S.D	Mean ±	S.D
DFs	16.62 ±	0.57	16.62 ±	0.49	16.73 ±	0.45	16.43 ±	0.55	15.68 ±	0.93
DFr	12.54 ±	0.76	12.72 ±	0.57	12.87 ±	0.51	12.27 ±	0.69	10.91 ±	0.96
AFs	3.00 ±	0.00	3.00 ±	0.00	3.00 ±	0.00	3.41 ±	1.91	3.02 ±	0.21
AFr	9.80 ±	0.73	9.68 ±	0.55	10.02 ±	0.53	8.50 ±	1.81	8.73 ±	1.05
PF	12.80 ±	0.99	13.14 ±	0.57	13.33 ±	0.47	12.52 ±	1.81	12.82 ±	0.39
PcFs	1.00 ±	0.00	1.00 ±	0.00	1.00 ±	0.00	1.09 ±	0.42	1.00 ±	0.00
PcFr	4.84 ±	0.37	5.00 ±	0.00	5.00 ±	0.00	5.20 ±	0.95	5.00 ±	0.00
CF	17.88 ±	0.75	17.68 ±	0.84	17.93 ±	0.38	17.64 ±	0.78	17.94 ±	0.35
SLL	36.80 ±	2.53	34.74 ±	1.26	36.07 ±	2.35	35.73 ±	1.34	36.00 ±	2.29
SALL	4.74 ±	0.48	6.28 ±	7.99	4.70 ±	0.40	4.34 ±	0.43	4.70 ±	0.40
SBLL	9.20 ±	1.37	6.74 ±	0.43	8.68 ±	0.75	7.77 ±	0.66	8.74 ±	0.79
SBDF	11.42 ±	1.50	9.44 ±	1.03	11.02 ±	1.15	11.30 ±	1.21	10.88 ±	1.48
BF	3.82 ±	0.48	3.68 ±	0.51	3.42 ±	0.50	3.05 ±	0.21	3.65 ±	0.48
FLGR	25.48 ±	2.61	24.50 ±	3.61	26.67 ±	3.17	28.20 ±	3.17	24.50 ±	2.34

Morphometric analysis by Principal Component Analysis (PCA)

In Pauk Chaung Market, the Principal Component Analysis explained 72.849 % (λ = 12.384) variability in Component (PC 1) and 11.824 % (λ = 2.010) in PC 2, together explained 84.673 % (λ = 14.394) of the variability indicating that the PCA was largely significant different among morphometric characters (Table. 2).

Table 2 Summary of total variance explained by Principal Component Analysis

Markets	Components	Eigenvalues	% Variances	Total %
Pauck Chaung	PC 1	12.384	72.849	
	PC 2	2.010	11.824	84.673
Wun Zin	PC 1	13.516	79.503	
	PC 2	1.177	6.923	86.426
Myo Ma Central	PC 1	11.238	66.105	
	PC 2	1.418	8.343	
	PC 3	1.056	6.214	80.662
Taw Ma	PC 1	13.278	78.106	
	PC 2	1.487	8.745	86.851
Myo Thit	PC 1	12.820	75.411	
	PC 2	1.364	8.026	83.437

The scree plot revealed the first two PCs had the most variables of characters from the data and the curve started flattened out at the third component indicating that its components were significant, while other components were not significant having with Eigenvalues under the red line λ < 1 (Fig. 2). PCA biplot showed the positive correlation on the clusters located around the PC 1. Although interorbital width and mouth length were positively correlated with each other, these two were negatively correlated with SnL, AFL, PrDL, HL, CFL, DFL, PcFL, CL, and SL (Fig. 3).

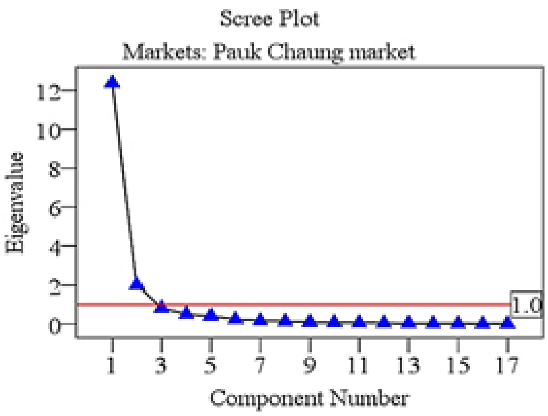

Figure 2 Scree plot on principal components of morphometric characters of *Oreochromis niloticus* at Pauk Chaung market

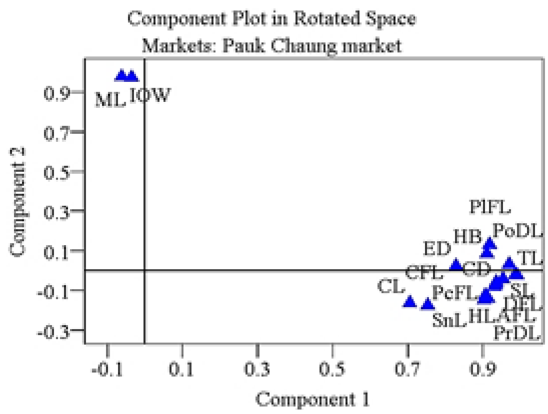

Figure 3 Component plot in rotated spaces from Pauk Chaung market

In Wun Zin market, PCA explained 79.503 % (λ = 13.516) variability in PC 1 and 6.923 % (λ = 1.177) in PC 2, together explained 86.426 % (λ = 14.693) variability (Table. 2). The scree plot revealed the first two PCs had the most variables while other components were not significant having with Eigenvalues under the red line λ < 1 (Fig. 4). The loading components were found on the right side of the top explained the positively correlated; however, the snout length (SnL) was no correlation with interorbial width (IOW), caudal fin length (CL) and dorsal fin length (DFL) (Fig. 5).

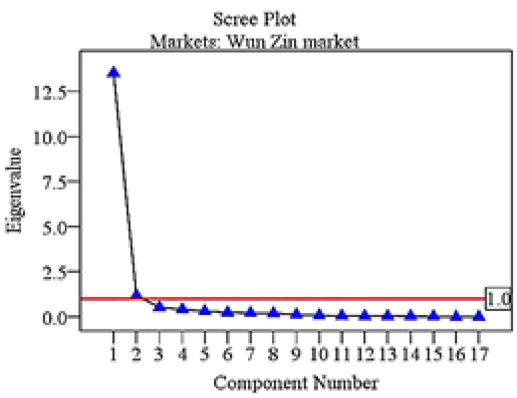

Figure 4 Scree plot of principal components of morphometric characters of *Oreochromis niloticus* at Wun Zin market

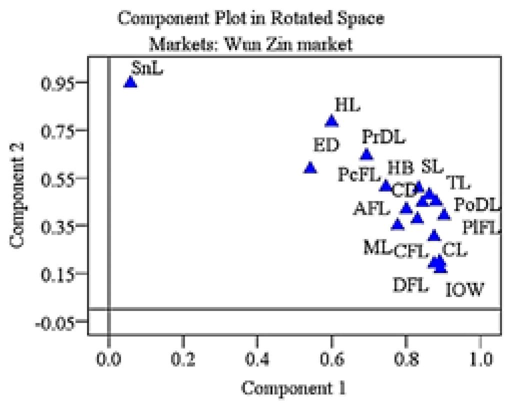

Figure 5 Component plot in rotated spaces from Wun Zin market

In Myo Ma Central market, PCA explained 66.105 % (λ = 11.238) variability in Component (PC 1), 8.343 % (λ = 1.418) in PC 2 and 6.214 % (λ = 1.056) in PC 3, with 80.662 % (λ = 13.712) of the total variability (Table. 2). The scree plot revealed the first three PCs had the most variables while other components were not significant having with Eigenvalues under the red line λ < 1 (Fig. 6). The most variation was found in PC 1 followed by PC 2 and PC 3 revealed the positively correlated on the loading plots PC 1 and PC 2. In addition, the snout length PC 3 was positively correlated with other factors (Fig. 7).

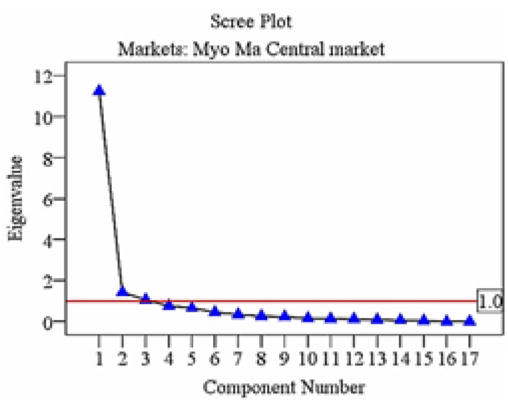

Figure 6 Scree plot of principal components of morphometric characters of *Oreochromis niloticus* at Myo Ma Central market

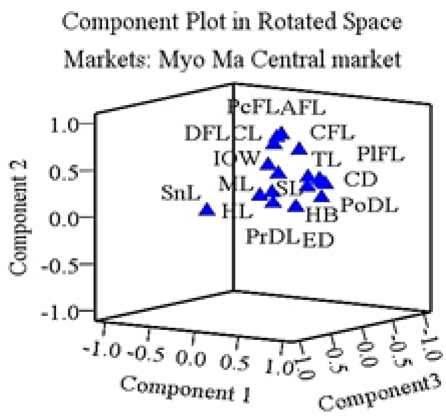

Figure 7 Component plot in rotated spaces from Myo Ma Central market

In Taw Ma market, PCA explained 78.106 % (λ = 13.278) of the variability in PC 1 and 8.745 % (λ = 1.487) in PC 2, together explained 86.851 % (λ = 14.765) variability indicating that the PCA was largely significant different among morphometric characters (Table. 2). The scree plot revealed the first two PCs had the most variables of characters from the data; however, the other components were not significant having with Eigenvalues under the red line λ < 1 (Fig. 8). The loading components were found on the plot 1 showed that the snout length was no correlated with mouth length; however, it was positively correlated with other factors. Four groups of closely correlated factors were (1) interorbital width and mouth length; (2) pelvic fin length, dorsal fin length, and pectoral fin length; (3) caudal depth, height of the body and total length; and (4) head length and predorsal length were found (Fig. 9).

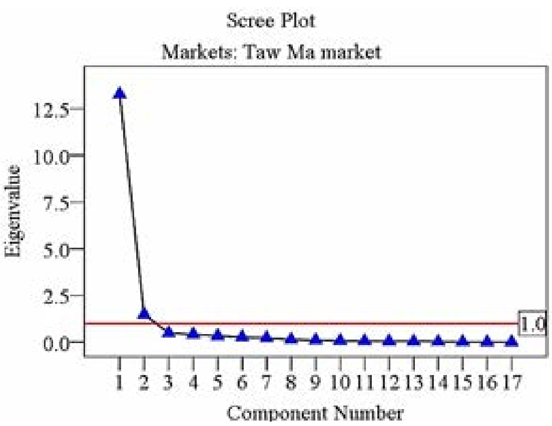

Figure 8 Scree plot of principal components of morphometric characters of *Oreochromis niloticus* at Taw Ma Market

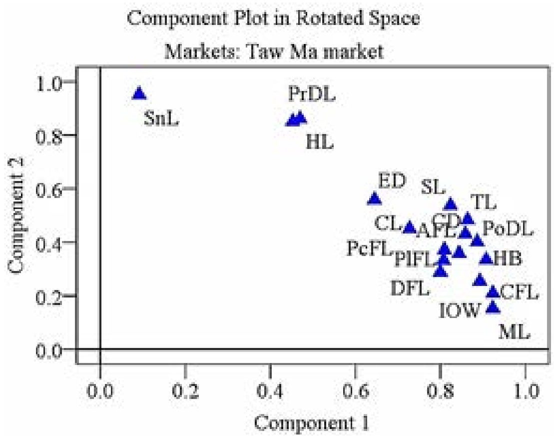

Figure 9 Component plot in rotated spaces from Taw Ma market

In Myo Thit market, PCA explained 75.411 % (λ = 12.820) variability in PC 1 and 8.026 % (λ = 1.364) in PC 2, together explained 83.437 % (λ = 14.184) variability indicating that the PCA was largely significant different among morphometric characters (Table. 2). The scree plot revealed the first two PCs had the most variables of characters from the data; however, the other components were not significant having with Eigenvalues under the red line λ < 1 (Fig. 10). The loading components were also found on the plot 1 showed that the snout length was not correlated with mouth length and interorbital width; however, other loading factors were positively correlated. The mouth length and interorbital width showed more positive correlation with other variables except with snout length (Fig. 11).

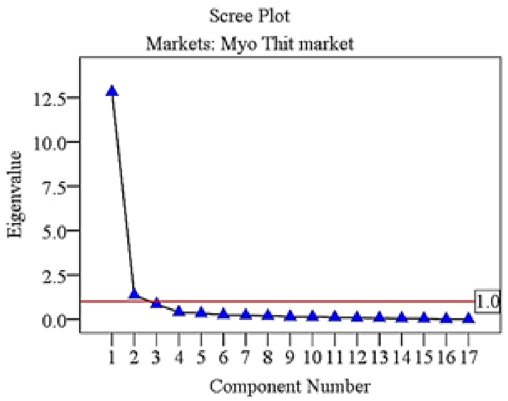

Figure 10 Scree plot of principal components of morphometric characters of *Oreochromis niloticus* at Myo Thit market

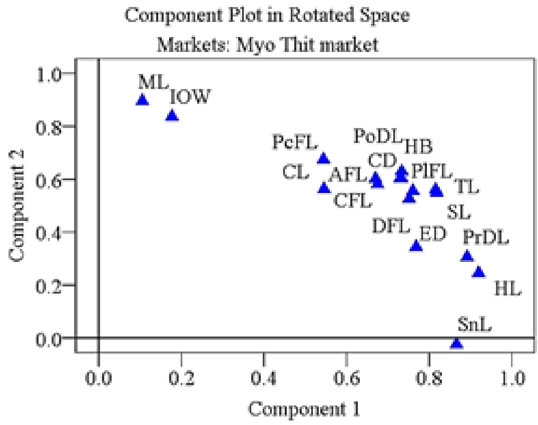

Figure 11 Component plot in rotated spaces from Myo Thit market

Percent relation of morphometric parameters

In order to better understanding the growth performance of Nile tilapia species in Meiktila, the percent relation of total length to 12 morphometric measurements and head length to 4 morphometric measurements were investigated. The mean percent relationship of total length to 12 morphometric measurements revealed positive allometric growth patterns (b > 1) with highly significant correlation coefficient as well as negative allometric growth patterns (b < 1 in length and b < 3 in weight) with low correlation growth performance. In addition, the characters on head length showed low correlation coefficient with negative allometric growth patterns (b < 1), except the relationship of snout length and head length (Table 3).

Diagnostic characters revealed

The most striking patterns of Nile tilapia were observed in Pauk Chaung market and Myo Thit market. They exhibited the inheritance characters of *Oreochromis aureus* (Plate 2) and *Oreochromis mossambicus* (Plate 3)

Plate 2. Representative caudal fin pattern of *Oreochromis* sp.

Plate 3. Representative caudal fin, dorsal fin and mouth patterns of *Oreochromis* sp.

Table 3 Percent relation of total length and head length to other body parts of Nile tilapia *Oreochromis niloticus*

Percentage	Pauk Chaung market (n = 50)			Wun Zin market (n = 50)			Myo Ma market (n = 55)			Taw Ma market (n= 44)			Myo Thit market (n = 66)		
	M	Y= a + bx	R^2	M	Y= a + bx	R^2	M	Y= a + bx	R^2	M	Y= a + bx	R^2	M	Y= a + bx	R^2
SL % TL	81.40	Y = - 0.26 + 1.01 x	0.99	80.69	Y = - 0.25 + 1.01 x	0.99	80.73	Y = - 0.25 + 1.01 x	0.99	79.59	Y = - 0.18 + 0.99 x	0.98	80.44	Y = - 0.39 + 1.03 x	0.99
PrDL % TL	24.70	Y = - 1.21 + 0.96 x	0.85	25.66	Y = - 0.69 + 0.86 x	0.86	24.88	Y = - 1.24 + 0.97 x	0.71	25.49	Y = 0.17 + 0.68 x	0.65	24.65	Y = - 1.78 + 1.08 x	0.82
PoDL % TL	56.57	Y = - 0.72 + 1.03 x	0.97	55.04	Y = - 0.95 + 1.07 x	0.98	55.80	Y = - 0.69 + 1.02 x	0.91	54.04	Y = - 1.26 + 1.13 x	0.97	55.79	Y = - 0.61 + 1.01 x	0.95
HL % TL	26.50	Y = - 1.30 + 0.99 x	0.79	27.13	Y = - 0.39 + 0.81 x	0.77	26.75	Y = - 1.68 + 1.07 x	0.69	26.93	Y = - 0.66 + 0.86 x	0.68	26.73	Y = - 1.77 + 1.09 x	0.73
DFL % TL	16.56	Y = - 2.92 + 1.22 x	0.86	15.58	Y = - 2.57 + 1.15 x	0.73	16.04	Y = - 3.57 + 1.35 x	0.61	17.56	Y = - 3.33 + 1.33 x	0.65	16.91	Y = - 2.71 + 1.19 x	0.80
AFL % TL	17.08	Y = - 2.42 + 1.13 x	0.83	16.96	Y = - 2.84 + 1.22 x	0.81	16.29	Y = - 2.34 + 1.11 x	0.50	16.75	Y = - 3.46 + 1.34 x	0.77	17.00	Y = - 2.43 + 1.13 x	0.76
PlFL % TL	31.74	Y = - 1.34 + 1.04 x	0.70	31.05	Y = - 1.84 + 1.14 x	0.78	31.37	Y = - 0.61 + 0.89 x	0.48	28.41	Y = - 1.57 + 1.06 x	0.70	32.15	Y = - 1.88 + 1.15 x	0.85
PcFL % TL	22.84	Y = - 2.63 + 1.23 x	0.81	24.13	Y = - 1.81 + 1.08 x	0.76	22.89	Y = - 1.13 + 0.93 x	0.49	21.75	Y = - 3.15 + 1.34 x	0.74	26.20	Y = - 1.52 + 1.04 x	0.66
CFL % TL	19.40	Y = - 1.73 + 1.02 x	0.86	19.55	Y = - 1.43 + 0.96 x	0.83	19.42	Y = - 1.76 + 1.03 x	0.74	20.50	Y = - 1.67 + 1.02 x	0.79	19.58	Y = - 0.94 + 0.86 x	0.79
CL % TL	8.21	Y = - 1.12 + 0.72 x	0.45	8.30	Y = - 2.32 + 0.96 x	0.79	8.37	Y = - 2.07 + 0.92 x	0.45	8.73	Y = - 2.66 + 1.05 x	0.71	8.05	Y = - 2.52 + 1.00 x	0.60
CD % TL	11.69	Y = - 2.08 + 0.99 x	0.92	11.24	Y = - 2.33 + 1.03 x	0.92	11.56	Y = - 1.60 + 0.89 x	0.76	11.77	Y = - 2.19 + 1.01 x	0.92	11.77	Y = - 2.00 + 0.97 x	0.89
HB % TL	36.14	Y = - 0.86 + 0.97 x	0.82	33.75	Y = - 1.13 + 1.01 x	0.93	34.89	Y = - 0.79 + 0.95 x	0.75	32.24	Y = - 1.82 + 1.14 x	0.90	35.56	Y = - 1.39 + 1.07 x	0.88
SnL % HL	19.55	Y = - 4.89 + 1.89 x	0.81	21.70	Y = - 2.08 + 1.16 x	0.54	18.16	Y = - 4.23 + 1.70 x	0.62	19.11	Y = - 2.49 + 1.24 x	0.69	17.45	Y = - 4.10 + 1.65 x	0.74
ED % HL	29.76	Y = 0.21 + 0.61 x	0.62	30.67	Y = - 0.23 + 0.73 x	0.64	31.46	Y = 0.07 + 0.66 x	0.47	30.91	Y = - 0.56 + 0.82 x	0.61	32.70	Y = - 0.18 + 0.74 x	0.70
IOW % HL	60.22	Y = 3.97 - 0.23 x	0.02	44.55	Y = - 0.53 + 0.92 x	0.43	42.45	Y = 0.39 + 0.65 x	0.32	40.97	Y = - 0.20 + 0.80 x	0.38	43.39	Y = 0.95 + 0.50 x	0.23
ML % HL	47.97	Y = 3.30 - 0.12 x	0.01	38.54	Y = - 0.70 + 0.93 x	0.56	34.32	Y = - 0.13 + 0.74 x	0.52	34.19	Y = - 0.50 + 0.83 x	0.29	32.83	Y = 1.14 + 0.37 x	0.19
Weight	53.22	Y = - 8.30 + 2.46 x	0.71	32.21	Y = - 9.15 + 2.63 x	0.85	36.53	Y = - 8.41 + 2.45 x	0.62	33.20	Y = - 10.93 + 2.97 x	0.92	38.32	Y = - 7.35 + 2.23 x	0.72

M = mean, SD = standard deviation, a = initial growth coefficient, b = estimated growth, R^2 = coefficient of determination

Discussion

The recorded samples of *Oreochromis niloticus* showed the mean percent total length was ranged from 79.59 mm in Taw Ma market to 81.40 mm in Pauk Chaung market and their mean weight were ranging from 32.21 g in Wun Zin market to 53.22 g in Pauk Chaung market. The meristic counts on Nile tilapia *Oreochromis niloticus* from five markets were not largely changed among them indicating that tilapia maintain their inheritance characters of genus *O.niloticus*.

However, the scree plot relative to biplot generated by Principal Component Analysis (PCA) using Pearson correlation exhibited the variable morphological characters among population. PCA components showed the more Eigenvalues lead to more variation among characters from the actual data. Among five markets, λ = 13.516 in Wun Zin was the highest in PC 1 and the lowest λ = 1.056 in PC 3 in Myo Ma Central market. The morphological variations among population revealed that similar degrees of variation were observed among population with 84.673 % in Pauk Chaung market, 86.426 % in Wun Zin market, 80.662 % in Myo Ma Central market, 86.851 % in Taw Ma market and 83.437 % in Myo Thit market, respectively.

Among 17 morphometric characters, the largely significant variation with low correlation in dorsal fin (r^2 = 0.61), anal fin length (r^2 = 0.50), pectoral fin (r^2 = 0.48), pelvic fin (r^2 = 0.49), caudal peduncle length (r^2 = 0.45), eye diameter (r^2 = 0.47), interorbital width (r^2 = 0.32), and mouth length (r^2 = 0.52) found especially in Myo Ma Central market compared with the other four markets. In addition, the percent relation of head length showed low correlation of head parts in five markets. These results are strongly recommended to Kosi *et al .,* (2014) who reported that the growth of different morphological body parts of the fish in relation to its least growth changes in those parameters over the fish size.

In this study, the significant differences of morphological traits were observed among the population with either dorsal fin insertion was similar or different with insertion of pectoral and pelvic fins, the distance between the insertion point of pectoral fin and pelvic, the position of insertion point of anal fin, the end of the dorsal fin and anal fin, the position of the eye on the angle of anterior end of mouth and insertion point of dorsal spine, and most of the short snout length found were long snout length relative to head length, respectively. Moreover, the percent of growth performance on length-length relationship showed positive and negative allometric growth patterns ($b < 1$ and $b > 1$) observed among intra-population and inter-population. In addition, growth development of coefficient determination R^2 values indicated the strong linear relationship among the length-length relationships. It was concluded that their growth patterns increase with temporal lines instead of linear relationship.

Moreover, the relation of length-weight relationships of tilapia population showed negative allometric growth ($b < 3$) indicating that their body compositions with less fat and thin. These results are strongly recommended the highest variation among population may be due to the availability of food requirements and the physical condition of water quality. However, these morphological variations are depending on the environmental condition rather than the genetic control (Ikpeme *et al.* 2017). Furthermore, these results are correspondence with Khallaf *et al.,* (2003) that the unfavorable environmental conditions such as stress, sex, season, availability of feeds and other water quality parameter impact on morphological variations.

Furthermore, the striking patterns of mix characters revealed in some tilapia species found in Myo Thit and Pauk Chaung markets due to the hybridization set up in closely related species. Most of the characters such as black oblique bands on dorsal fin rays and mixed stripe bands on caudal fin must be inheritance from *Oreochromis aureus*. Some fishes exhibited the significant characters of mouth shape, caudal fin and deep notched between dorsal fin spines and rays inherited from *O. mossambicus* and *O.aureus.* These results are consistent with the hybrids had indistinct or incomplete caudal fin barring; red hybrids have been developed to combine different traits of different tilapia species, and mossambicus lateral spots, partly caudal fin barred and iris yellowish and low dorsal fin (Fulton and Hall, 2014; Hill, 2017).

To sum up, the data among five populations from different markets have been clearly shown the real characteristics of remarkable patterns relation to their growth performance which would be very useful for stock management of fishery products as well as the scientific researchers.

Conclusion

The meristic analysis revealed more constant than biometric parameters. The Principal Component Analysis (PCA) generated the significant variable morphometric characters relation to their different population from five markets. The percent relation of length-length relationship to composition of body parts of tilapia species showed the different growth performance. In addition, the mixed characters of *Oreochromis* sp. indicated the hybridizing setting up in the local population. This information may provide the stock management of aquaculture resource concerning with the requirements of local fishermen.

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