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Sexual Dimorphism of Morphometrics and Meristics of *Carangoides Bajad* (Forsskål, 1775) and *Caranx Melampygus* (Cuvier, 1833) from the Southern Red Sea, Egypt

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Running Title: Sexual dimorphism of morphometrics and meristics of some Carangid Species

Abstract: ***In the present investigation, discrimination between sexes in each of Carangoides bajad and Caranx melampygus from the Red Sea of Egypt was possible by using morphometric indices. The type of size allometry in each of males and females of the two aforementioned species was estimated according to the bivariate concept. No sexual dimorphism was observed in the meristics of each of Carangoides bajad and Caranx melampygus under investigation.***

Keywords: Morphometrics, Meristics, sexual dimorphism, *Carangoides bajad*, *Caranx melampygus*, *Carangidae*, Red Sea, Egypt.

1. Introduction

Morphometric characters of fishes were found to be of taxonomic importance in sex, race and species identification by many investigators (Haug and Fevolden, 1986; Mekkawy, 1987, 1994; Khalil *et al*., 1982, 1984; Mahmoud, 1988, 1991, 1993; Harabawy, 1993, 2002; Oliveira and Almada, 1995; Osman, 2000; Costa *et al*., 2003; Obady, 2003; Smith and Paulin, 2003; Basmidi, 2004; Turan, 2004; Lawson, 2010; Simon *et al*., 2010; Elamin *et al*., 2011; Mekkawy and Mohammad, 2011; Mazlan *et al*., 2012; Deepti *et al*., 2013; Sajina *et al*., 2013; Jawad, 2015; Masood *et al*., 2015 and Zubia *et al*., 2015).

The meristic characters were also found to be valid in sex, race and species identification (Mahmoud and Mekkawy, 1991; Mahmoud, 1991, 1993, 2002; Mekkawy, 1991, 1997; Costa *et al*., 2003; Obady, 2003; Basmidi, 2004; Turan, 2004; Lawson, 2010; Simon *et al*., 2010; Mekkawy and Mohammad, 2011; Mazlan *et al*., 2012; Sajina *et al*., 2013; Masood *et al*., 2015 and Zubia *et al*., 2015).

In the present investigation, the morphometric and meristic characters were used to elucidate sexual dimorphism of *Carangoides bajad,* (Forsskål, 1775), and *Caranx melampygus,* (Cuvier, 1833) from the Southern Red Sea of Egypt.

2. Materials and Methods

Morphometrics: In the present investigation, 102 males (180 – 475 mm in Standard Length (SL) and 83 females (191 – 475 mm in SL) of *Carangoides bajad* and 71 males (147 – 507 mm in SL) and 53 females (156 – 503 mm in SL) of *Caranx melampygus* were randomly collected from the southern Red Sea, at Elba National Park (Shalateen fishing port) 520 Km southern of Hurghada, Egypt during the period from January 2014 to December 2014.

For each fish, 23 morphometric measurements were made on the left side up to the nearest millimeter using a divider and a measuring board. The following is a list of these measurements which are diagrammatically represented in Figure 1; each measurement is labeled on this figure by its corresponding number indicated in such a list. Those morphometric measurements included:

1. Total length (**TL**).
2. Fork length (**FL**).
3. Standard length (**SL**).
4. Body depth (**BD**).
5. Head length (**HL**).
6. Eye diameter (**EyD**).
7. Snout length (**SnL**).
8. Postorbital length (**POL**).
9. Upper jaw length (**UJL**).
10. Curved lateral line segment length (**CLL**).
11. Straight lateral line segment length (**SLL**).
12. Soft dorsal fin base length (**SDFL**).
13. Soft anal fin base length (**SAFL**).
14. Soft dorsal fin height (**SDFH**).
15. Soft anal fin height (**SAFH**).
16. Pectoral fin length (**PFL**).
17. Distance between the first soft dorsal fin ray and the first soft anal fin ray (**SDSAFL**).
18. Distance between anal and dorsal fin insertions (**ADFEL**).
19. Distance between the first spine of the dorsal fin and the first soft anal fin ray (**SpDASFL**).
20. Distance between the first soft dorsal fin ray and ventral fin origin (**SDVOFL**).
21. Distance between the first soft dorsal fin ray and the insertion of anal fin (**SDEAFL**).

22. Distance between the insertion of dorsal fin and the first soft anal fin ray (**EDSAFL**).
23. Predorsal fin length (**PRDFL**)

Meristics: Certain Meristic counts of 102 males and 83 females of *Carangoides bajad* and 71 males and 53 females of *Caranx melampygus* were considered. The following meristic counts were recorded:

1. Number of dorsal fin soft rays **(DFR)**.
2. Number of the pectoral fin soft rays **(PFR)**.
3. Number of anal fin soft rays **(AFR)**.
4. Number of gill rakers on the epibranchial portion of the first left gill arch (ascending) **(UGR)**.
5. Number of gill rakers on ceratohypo-branchial portion of the first left gill arch (descending) **(LGR)**.
6. Total number of gill rakers on the first left gill arch **(TGR)**.

Statistical analysis: The basic statistics of certain morphometric indices (relative to standard length, SL or head length, HL) and meristic characters were estimated. The allometric coefficients of the raw morphometric characters and their relationships with fish size (SL) were estimated using power function equation and linear regression model respectively. The simple power function or allometric equation of Huxely (1932):

$$Y=aX^b$$

was used, where Y and X are dependent and independent variables respectively and a and b (the allometric coefficient) are constants. The parameters a and b of this equation were estimated by fitting a linear equation to the logarithmic values of Y and X according to the least square method. This leads to an equation of the form:

$$\text{Log } Y = \text{Log } a + b \text{ Log } X$$

Moreover, the type of allometry was determined by estimating the confidence limits of the allometric coefficients, isometry (I), negative allometry (-) or positive allometry (+). The type of allometry was evaluated by testifying the significance of the allometric coefficients (b) (b=1, b>1 and b<1 for isometric growth, positive allometric growth and negative allometric growth respectively) that serves as a criterion for the intensity of differential increase in the morphological characters relative to a certain reference length. The type of allometry was found to be helpful for studying sexual dimorphism of the *Carangoides bajad* and *Caranx melampygus* .The mean values of meristic characters within species considered is testified by t-test.

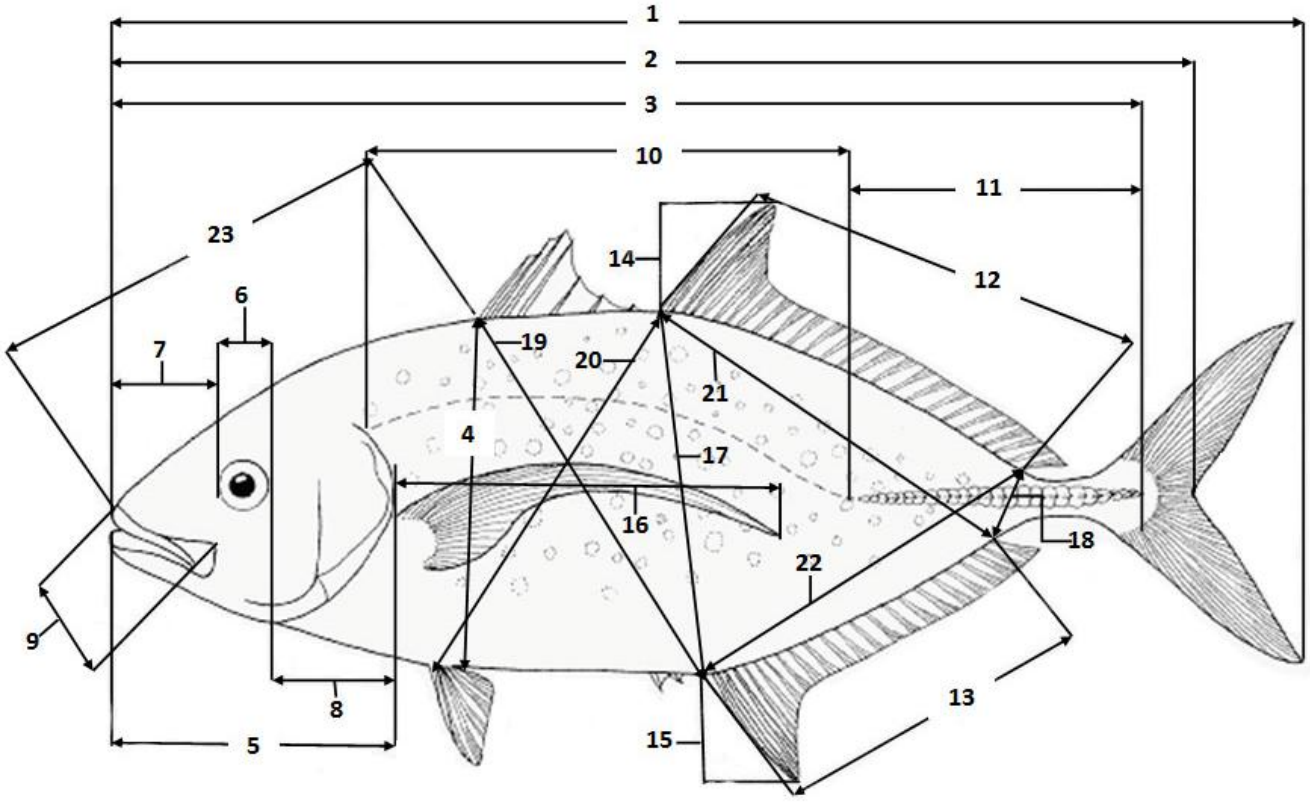

Figure 1: Schematic illustration of measurements taken on the body of the two Carangidae Species considered from the southern Red Sea, Egypt.

3. Results

Morphometrics

The relationship between the morphometric characters and fish size (SL) of *Carangoides bajad* and *Caranx melampygus* were best described by the linear regression equations (Tables 1 and 2). The basic statistics of the morphometric indices (relative to SL or HL) of *Carangoides bajad* considered show sexual dimorphism (Tables 3, and 4). HL/SL, SLL/SL, SDVOFL/SL, EDSAFL/SL, PRDFL/SL, BD/HL, CLL/HL, SLL/HL and ADFEL/HL are indices to be size-free and so valid as a discriminating tool between males and females of *Carangoides bajad*. The other indices exhibited variable mode of growth with

fish size within species, so could not be considered in sexual dimorphism.

The basic statistics of the morphometric indices (relative to SL or HL) of *Caranx melampygus* considered show sexual dimorphism (Tables 5, and 6). PRDFL/SL, PFL/HL, SpDASFL/HL, SDEAFL/HL and EDSAFL/HL are indices to be size-free and so valid as a discriminating tool between males and females of *Caranx melampygus*. The other indices exhibited variable mode of growth with fish size within species, so could not be considered in sexual dimorphism.

The patterns of variations in the morphometric characteristics of the two *Carangidae* Species were considered in terms of their mode of growth; i.e., their type of allometry. Except for EyD, SDFL, SDFH and SAFH for males; EyD, SDFL, SDFH and SAFH for females of *Carangoides bajad* and EyD and SDFL for males; BD, EyD, CLL and SDFL for females of *Caranx melampygus*, all other morphometric characters of the two *Carangidae* species exhibited positive allometric growth (Table 7 and 8).

Table 1: The relationship between some morphometric parameters and standard length of ***Carangoides bajad*** collected from the southern Red Sea of Egypt for future prediction of missing parameters.

The equation	R*	The equation	R*
FL = 0.8614 + 1.09***SL**	0.99	**BD** = - 10.15 + 0.43***SL**	0.91
HL = 74.73 + 0.12***SL**	0.95	**EyD** = 9.96 + 0.02***SL**	0.50
SnL = - 4.56 + 0.14***SL**	0.93	**POL** = - 5.08 + 0.14***SL**	0.94
UJL = 1.66 + 0.12***SL**	0.92	**CLL** = - 6.94 + 0.44***SL**	0.94
SLL = - 3.61 + 0.36***SL**	0.93	**SDFL** = 11.38 + 0.35***SL**	0.93
SAFL = 4.56 + 0.34***SL**	0.96	**SDFH** = 14.88 + 0.09***SL**	0.57
SAFH = 13.82 + 0.09***SL**	0.60	**PFL** = 4.52 + 0.37***SL**	0.95
SDSAFL = 1.49 + 0.42***SL**	0.99	**ADFEL** = - 2.47 + 0.10***SL**	0.98
SpDASFL = 3.89 + 0.45***SL**	0.99	**SDVOFL** = - 0.08 + 0.47***SL**	0.99
SDEAFL = 2.48 + 0.43***SL**	0.99	**EDSAFL** = 0.28 + 0.40***SL**	0.99
PRDFL = 0.09 + 0.43***SL**	0.96		

*Correlation is significant at the 0.01 level.

Table 2: The relationship between some morphometric parameters and standard length of ***Caranx melampygus*** collected from the southern Red Sea of Egypt for future prediction of missing parameters.

The equation	R*	The equation	R*
FL = 7.87 + 1.08***SL**	0.99	**BD** = 16.98 + 0.37***SL**	0.96
HL = 5.88 + 030***SL**	0.98	**EyD** = 12.49 + 0.01***SL**	0.52
SnL = - 1.81 + 0.12***SL**	0.97	**POL** = - 6.43 + 0.16***SL**	0.97
UJL = 3.67 + 0.12***SL**	0.96	**CLL** = 11.07 + 0.35***SL**	0.93
SLL = - 19.51 + 0.47***SL**	0.95	**SDFL** = 17.84 + 0.33***SL**	0.97
SAFL = 13.55 + 0.31***SL**	0.98	**SDFH** = 5.46 + 0.19***SL**	0.92
SAFH = 7.89 + 0.16***SL**	0.91	**PFL** = 7.48 + 0.37***SL**	0.98
SDSAFL = 9.78 + 0.41***SL**	0.99	**ADFEL** = - 3.55 + 0.12***SL**	0.99
SpDASFL = 4.67 + 0.48***SL**	0.99	**SDVOFL** = 2.04 + 0.48***SL**	0.99
SDEAFL = 7.39 + 0.43***SL**	0.99	**EDSAFL** = 7.11 + 0.39***SL**	0.99
PRDFL = 2.33 + 0.44***SL**	0.98		

*Correlation is significant at the 0.01 level.

Table 3: The basic statistics (mean ± standard error and range) of morphometric indices (relative to SL) of males, females and combined sexes of ***Carangoides bajad*** collected from the southern Red Sea of Egypt.

Morphometric index	Males		Females		Combined sexes	
	Mean±SE	Range	Mean±SE	Range	Mean±SE	Range
BD	39.11±0.27	33.1-44.7	38.67±0.31	32.7-44.4	38.9±0.20*	32.7-44.7
HL	31.55±0.16	28.2-36.1	31.40±0.17	27.7-36.6	31.5±0.12	27.7-36.6
EyD	5.71±0.08**	4-8.5	5.70±0.09**	3.6-7.3	5.7±0.06	3.6-8.5
SnL	12.07±0.09**	10.1-14	12.13±0.09**	9.9-13.9	12.1±0.06**	9.9-14.0
POL	12.38±0.08**	10.6-14.7	12.29±0.09**	10.5-14.6	12.3±0.06**	10.6-14.8
UJL	12.72±0.08*	10.9-15.6	12.59±0.08	11-14.6	12.7±0.06*	11.0-15.6
CLL	41.28±0.22	33.8-45.9	42.13±0.23*	37.3-48.5	41.7±0.16*	33.9-48.5
SLL	34.53±0.22	28.2-42.1	33.77±0.22	29.1-39.3	34.2±0.16	28.2-42.1
SDFL	39.03±0.22**	34.6-44.9	39.07±0.28**	32.8-47.2	39.0±0.18**	32.8-47.2
SAFL	35.46±0.16**	32.3-40.5	35.51±0.18	33-40.4	35.5±0.12**	32.3-40.5
SDFH	14.95±0.23**	9.9-22.2	15.00±0.24**	12.4-23.2	15.0±0.17**	9.9-23.2
SAFH	14.08±0.20**	11.5-21.6	13.96±0.22**	10.1-20	14.0±0.15**	10.1-21.6
PFL	38.76±0.18*	33.3-43.2	38.76±0.17	35-43.6	38.8±0.13*	33.3-43.6
SDSAFL	42.10±0.08**	39.8-46.3	42.06±0.09	38.8-47.4	42.1±0.06*	38.8-47.4
ADFEL	9.42±0.03**	8.1-10.8	9.39±0.04**	7.9-10.4	9.4±0.02**	7.9-10.8
SpDASFL	46.74±0.12**	44.4-54.3	46.68±0.09	43-50	46.7±0.08**	43.0-54.4
SDVOFL	46.70±0.06	44.7-50	46.65±0.07	43.3-49.1	46.7±0.04	43.4-50.0
SDEAFL	43.71±0.07**	40.9-48.6	43.81±0.09	40.3-46.9	43.8±0.06**	40.3-48.7
EDSAFL	39.99±0.05	38.3-43.2	40.03±0.06	36.9-42.4	40.0±0.04	36.9-43.2
PRDFL	42.73±0.18	38.1-47.6	42.82±0.18	37.9-46.7	42.8±0.13	37.9-47.6
Range of Correlation Coefficient	**(-0.80)-(0.67)**		**(-0.85)-(0.77)**		**(-0.82)-(0.72)**	
N	**102**		**83**		**185**	

**Correlation with SL is significant at the 0.01 level.
*Correlation with SL is significant at the 0.05 level.

Table 4: The basic statistics (mean ± standard error and range) of morphometric indices (relative to HL) of males, females and combined sexes of ***Carangoides bajad*** collected from the southern Red Sea of Egypt.

Morphometric index	Males		Females		Combined sexes	
	Mean±SE	Range	Mean±SE	Range	Mean±SE	Range
SL	317.76±1.56*	277.1-354.8	319.30±1.71**	273.1-361.5	318.5±1.15**	273.1-361.5
BD	124.18±0.91	104.7-145.6	123.42±1.12	102.3-153.8	123.8±0.71	102.3-153.9
EyD	18.10±0.26**	12.9-25	18.17±0.29**	11.9-23.3	18.1±0.19**	11.9-25.0
SnL	38.30±0.26**	28.6-45.1	38.67±0.30*	29-45.3	38.5±0.20**	28.6-45.3
POL	39.27±0.23*	31.6-45.6	39.20±0.27**	32.9-45.2	39.2±0.18**	31.6-45.6
UJL	40.35±0.23**	31.6-45.2	40.15±0.27*	32.3-46.2	40.3±0.18**	31.6-46.2
CLL	131.10±0.85	110.1-150.6	134.51±1.00	117-161.5	132.6±0.66	110.1-161.5
SLL	109.71±0.87	92.3-134.6	107.79±0.86	91.3-128.6	108.8±0.62	91.3-134.6
SDFL	124.08±1.02**	100.9-153.4	124.89±1.35**	105.4-170.8	124.4±0.83**	100.9-170.8
SAFL	112.76±0.84**	92.9-139.7	113.49±0.99**	90.3-146.2	113.1±0.64**	90.3-146.2
SDFH	47.50±0.77**	31.5-70	47.97±0.87**	36.6-76.9	47.7±0.58**	31.5-76.9
SAFH	44.74±0.69**	33.9-66.7	44.68±0.83**	32.7-72.3	44.7±0.53**	32.7-72.3
PFL	123.14±0.77**	104.2-143.3	123.70±0.76**	105.4-149.2	123.4±0.54**	104.2-149.2
SDSAFL	133.78±0.67**	116.5-149.3	134.28±0.77**	115.1-152.3	134.0±0.51**	115.1-152.3
ADFEL	29.92±0.17	25-33.3	29.98±0.19	24-33.8	29.9±0.12	24.0-33.9
SpDASFL	148.50±0.77**	129.4-166.7	149.04±0.86**	128-169.2	148.7±0.57**	128.0-169.2
SDVOFL	148.37±0.75**	129.2-165.8	148.96±0.84**	126.9-169.2	148.6±0.56**	126.9-169.2
SDEAFL	138.88±0.72**	121.1-154.8	139.89±0.80**	119.4-158.5	139.3±0.54**	119.4-158.5
EDSAFL	127.07±0.63**	111-142.5	127.81±0.71**	109.7-144.6	127.4±0.47**	109.7-144.6
PRDFL	135.66±0.70	112.2-153.3	136.58±0.66**	116.1-160	136.1±0.49*	112.2-160.0
Range of Correlation Coefficient	(-0.82)-(0.70)		(-0.87)-(0.78)		(-0.84)-(0.74)	
N	102		83		185	

**Correlation with HL is significant at the 0.01 level.
*Correlation with HL is significant at the 0.05 level.

Table 5: The basic statistics (mean ± standard error and range) of morphometric indices (relative to SL) of males, females and combined sexes of ***Caranx melampygus*** collected from the southern Red Sea of Egypt

Morphometric index	Males		Females		Combined sexes	
	Mean±SE	Range	Mean±SE	Range	Mean ±SE	Range
BD	42.42±0.38**	36.1-51.5	42.85±0.53**	33.3-50.9	42.6±0.31**	33.3-51.5
HL	31.66±0.18**	28.6-37.7	31.73±0.24**	28.4-39	31.7±0.14**	28.4-39.0
EyD	5.63±0.19**	3.9-9.1	5.64±0.23**	3.4-8.9	5.6±0.15**	3.4-9.1
SnL	11.70±0.08*	10.2-13.1	11.79±0.10**	9.6-13.1	11.7±0.06**	9.6-13.1
POL	14.10±0.14**	10.8-16.2	13.76±0.17**	10.9-16.4	14.0±0.11**	10.8-16.4
UJL	13.46±0.12**	11.8-16.7	13.58±0.15**	11.2-17.3	13.5±0.10**	11.2-17.3
CLL	38.09±0.39	32.1-45.2	38.84±0.59**	30.9-50	38.4±0.34**	30.9-50.0
SLL	40.97±0.58*	27.4-48.5	39.65±0.78**	28.8-48.9	40.4±0.47**	27.4-48.9
SDFL	39.24±0.33**	32.3-47.4	39.63±0.36**	35.3-45.7	39.4±0.24**	32.3-47.4
SAFL	35.65±0.27**	30.3-42.3	35.91±0.32**	31.9-42.1	35.8±0.20**	30.3-42.3
SDFH	21.09±0.27**	17.1-29.3	20.42±0.28	16.2-24.7	20.8±0.20*	16.2-29.3
SAFH	18.56±0.31**	15.3-35.6	17.98±0.21	14.6-22.9	18.3±0.20**	14.6-35.6
PFL	39.17±0.26**	34.7-44.8	39.20±0.28**	34.8-43.6	39.2±0.19**	34.7-44.8
SDSAFL	44.49±0.18**	41.6-50.3	44.41±0.19**	41.5-47.4	44.5±0.13**	41.5-50.3
ADFEL	10.37±0.08**	8.2-11.9	10.36±0.09**	8.3-12	10.4±0.06**	8.2-12.0
SpDASFL	49.20±0.14**	44.1-52.4	49.15±0.14**	44.8-51.1	49.2±0.10**	44.1-52.4
SDVOFL	49.10±0.11	46-51.8	49.18±0.11**	46.5-52.8	49.1±0.08**	46.0-52.8
SDEAFL	45.03±0.14**	42.9-50	45.02±0.20**	41.5-48.9	45.0±0.12**	41.5-50.0
EDSAFL	41.34±0.14**	39.7-46.5	41.25±0.17**	39.1-45.6	41.3±0.11**	39.1-46.5
PRDFL	44.80±0.21	40.7-48.3	44.77±0.25	37.2-48	44.8±0.16	37.2-48.3
Range of Correlation Coefficient	(-0.928)-(0.778)		(-0.934)-(0.727)		(-0.93)-(0.73)	
N	71		53		124	

**Correlation with SL is significant at the 0.01 level.
*Correlation with SL is significant at the 0.05 level.

Table 6: The basic statistics (mean ± standard error and range) of morphometric indices (relative to HL) of males, females and combined sexes of ***Caranx melampygus*** collected from the southern Red Sea of Egypt

Morphometric index	Males		Females		Combined sexes	
	Mean±SE	Range	Mean±SE	Range	Mean±SE	Range
SL	316.46±1.69*	265.4-349.2	316.03±2.25*	256.4-352	316.3±1.36**	256.4-352.0
BD	134.01±1.00**	113.3-154.5	134.95±1.18**	115.9-158.2	134.4±0.76**	113.3-158.2
EyD	17.71±0.57**	12.4-30	17.67±0.67**	11.1-27.3	17.7±0.43**	11.1-30.0
SnL	37.01±0.28**	31.7-42	37.27±0.38**	29.2-42.7	37.1±0.23**	29.2-42.7
POL	44.64±0.52**	29.3-52	43.56±0.67**	30.8-51.6	44.2±0.42**	29.3-52.0
UJL	42.53±0.34	36.4-53.4	42.84±0.40	38.5-56.5	42.7±0.26*	36.4-56.5
CLL	120.35±1.15	100-143.5	122.28±1.45**	106.6-150	121.2±0.90*	100.0-150.0
SLL	129.80±2.09**	85.7-150.4	125.81±2.99**	75.6-154.5	128.1±1.75**	75.6-154.5
SDFL	123.98±0.92**	106.6-145.6	125.02±1.02**	112.4-145.2	124.4±0.68**	106.6-145.6
SAFL	112.71±0.84**	96-130.1	113.33±1.00**	101.4-132.3	113.0±0.64**	96.0-132.3
SDFH	66.67±0.86**	54.7-87.3	64.62±1.07*	46.2-79.3	65.8±0.67	46.2-87.3
SAFH	58.60±0.88**	48.5-106.3	56.81±0.72	42.3-71.6	57.8±0.60**	42.3-106.4
PFL	123.80±0.74	108.7-136.8	123.77±1.01	109-141.5	123.8±0.60	108.7-141.5
SDSAFL	140.73±0.75*	121.8-156	140.23±0.89	117.9-154.9	140.5±0.57**	118.0-156.0
ADFEL	32.84±0.33**	25.5-37.4	32.78±0.42**	25.6-38.4	32.8±0.26**	25.5-38.4
SpDASFL	155.66±0.86	132.1-170.3	155.27±1.06	128.2-171.2	155.5±0.67	128.2-171.2
SDVOFL	155.35±0.80*	130.8-171.2	155.42±1.13	126.9-172.7	155.4±0.66*	126.9-172.7
SDEAFL	142.44±0.73	121.8-155.1	142.21±1.01	117.9-160	142.3±0.60	118.0-160.0
EDSAFL	130.76±0.69	111.5-144	130.35±0.95	109-149.1	130.6±0.57	109.0-149.1
PRDFL	141.69±0.77*	114.7-151.3	141.37±0.99	114.1-151.7	141.6±0.61**	114.1-151.7
Range of Correlation Coefficient	(-0.925)-(0.708)		(-0.928)-(0.744)		(-0.93)-(0.69)	
N	71		53		124	

**Correlation with HL is significant at the 0.01 level.
*Correlation with HL is significant at the 0.05 level.

Table 7: Bivariate allometric coefficient and their standard errors (b±SE) of morphometric measurements derived by the power function equation of males, females and combined sexes of ***Carangoides bajad*** collected from the southern Red Sea of Egypt.

Morphometric Character	Males		Females		Combined sexes	
	b ± SE	a	b ± SE	a	b ± SE	a
BD	1.25±0.05 +	-0.41	1.24±0.05 +	-0.40	1.25±0.03 +	-0.40
HL	1.24±0.03 +	-0.45	1.31±0.04 +	-0.51	1.27±0.03 +	-0.47
EyD	0.68±0.08 -	-0.43	0.73±0.08 -	-0.48	0.70±0.06 -	-0.46
SnL	1.83±0.06 +	-1.21	1.85±0.06 +	-1.23	1.84±0.04 +	-1.22
POL	1.71±0.05 +	-1.09	1.87±0.05 +	-1.24	1.78±0.04 +	-1.16
UJL	1.44±0.05 +	-0.85	1.52±0.05 +	-0.93	1.48±0.04 +	-0.88
CLL	1.22±0.04 +	-0.37	1.24±0.04 +	-0.38	1.23±0.03 +	-0.37
SLL	1.22±0.04 +	-0.40	1.30±0.04 +	-0.48	1.26±0.03 +	-0.44
SDFL	1.04±0.03 **I**	-0.22	1.05±0.04 **I**	-0.23	1.05±0.03 **I**	-0.23
SAFL	1.11±0.03 +	-0.30	1.17±0.03 +	-0.36	1.14±0.02 +	-0.33
SDFH	0.80±0.10 -	-0.24	1.00±0.11 **I**	-0.42	0.89±0.07 -	-0.32
SAFH	0.87±0.09 -	-0.32	0.95±0.10 **I**	-0.40	0.91±0.07 **I**	-0.35
PFL	1.14±0.03 +	-0.31	1.16±0.03 +	-0.33	1.15±0.02 +	-0.32
SDSAFL	1.14±0.01 +	-0.29	1.17±0.02 +	-0.32	1.15±0.01 +	-0.30
ADFEL	1.82±0.03 +	-1.27	1.88±0.03 +	-1.33	1.85±0.02 +	-1.30
SpDASFL	1.09±0.02 +	-0.22	1.13±0.01 +	-0.26	1.11±0.01 +	-0.24
SDVOFL	1.15±0.01 +	-0.28	1.16±0.01 +	-0.29	1.15±0.01 +	-0.28
SDEAFL	1.13±0.01 +	-0.28	1.14±0.01 +	-0.28	1.14±0.01 +	-0.28
EDSAFL	1.18±0.01 +	-0.34	1.20±0.01 +	-0.35	1.19±0.01 +	-0.35
PRDFL	1.21±0.03 +	-0.35	1.17±0.03 +	-0.31	1.19±0.02 +	-0.33
Number	102		83		185	

(I) = Isometric growth, (-) = Negative allometric growth, (+) = Positive allometric growth.

Table 8: Bivariate allometric coefficient and their standard errors (b±SE) of morphometric measurements derived by the power function equation of males, females and combined sexes of ***Caranx melampygus*** collected from the southern Red Sea of Egypt.

Morphometric Character	Males		Females		Combined sexes	
	b ± SE	a	b ± SE	a	b ± SE	a
BD	1.07±0.03 +	-0.22	0.96±0.03 **I**	-0.12	1.02±0.02 **I**	-0.18
HL	1.20±0.02 +	-0.41	1.16±0.02 +	-0.37	1.18±0.02 +	-0.39
EyD	0.53±0.05 -	-0.28	0.40±0.07 -	-0.16	0.47±0.04 -	-0.23
SnL	1.71±0.03 +	-1.12	1.72±0.04 +	-1.13	1.71±0.03 +	-1.12
POL	1.77±0.04 +	-1.13	1.88±0.04 +	-1.23	1.82±0.03 +	-1.17
UJL	1.45±0.04 +	-0.85	1.35±0.04 +	-0.75	1.41±0.03 +	-0.81
CLL	1.18±0.04 +	-0.35	0.94±0.04 -	-0.13	1.08±0.03 +	-0.25
SLL	1.33±0.05 +	-0.47	1.60±0.05 +	-0.73	1.44±0.04 +	-0.58
SDFL	1.02±0.02 **I**	-0.19	1.02±0.02 **I**	-0.20	1.02±0.01 **I**	-0.19
SAFL	1.06±0.02 +	-0.25	1.06±0.02 +	-0.26	1.06±0.01 +	-0.25
SDFH	1.19±0.05 +	-0.49	1.53±0.06 +	-0.81	1.33±0.04 +	-0.62
SAFH	1.19±0.05 +	-0.53	1.41±0.05 +	-0.73	1.28±0.04 +	-0.61
PFL	1.14±0.02 +	-0.30	1.14±0.03 +	-0.31	1.14±0.02 +	-0.30
SDSAFL	1.08±0.01 +	-0.22	1.08±0.01 +	-0.23	1.08±0.01 +	-0.22
ADFEL	1.94±0.02 +	-1.36	1.90±0.03 +	-1.33	1.92±0.02 +	-1.35
SpDASFL	1.12±0.01 +	-0.24	1.11±0.01 +	-0.23	1.12±0.01 +	-0.24
SDVOFL	1.14±0.01 +	-0.26	1.12±0.01 +	-0.24	1.13±0.01 +	-0.25
SDEAFL	1.11±0.01 +	-0.25	1.09±0.01 +	-0.23	1.10±0.01 +	-0.24
EDSAFL	1.11±0.01 +	-0.27	1.11±0.01 +	-0.26	1.11±0.01 +	-0.27
PRDFL	1.16±0.02 +	-0.30	1.13±0.02 +	-0.27	1.15±0.01 +	-0.29
Number	**71**		**53**		**124**	

(**I**) = Isometric growth, (-) = Negative allometric growth, (+) = Positive allometric growth.

4. Meristics

The total, lower and upper gill raker counts of males and females of *Carangoides bajad* and *Caranx melampygus* are presented in Tables 9 and 10. These counts showed no sexual dimorphism. The means of dorsal, pectoral and anal fin rays counts of males and females of *Carangoides bajad* and *Caranx melampygus* showed no sexual dimorphism (Tables 11 and 12).

Table 9: The total, lower and upper gill raker counts of males and females of ***Carangoides bajad*** collected from the southern Red Sea of Egypt.

Total gill rakers (TGR)										
Counts	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**mean±SD**	**T-value**
Males	15	4	36	9	30	4	4	--	27.62±1.59	0.22
Females	12	6	28	9	21	4	1	2	27.57±1.65	
Upper gill rakers (UGR)										
Counts	**7**	**8**	**9**	**10**	--	--	--	--	**mean±SD**	**T-value**
Males	18	41	40	3	--	--	--	--	8.27±0.79	0.18
Females	15	37	26	5	--	--	--	--	8.25±0.82	
Lower gill rakers (LGR)										
Counts	**18**	**19**	**20**	**21**	**22**	--	--	--	**mean±SD**	**T-value**
Males	16	44	34	7	1	--	--	--	19.34±0.86	0.23
Females	16	34	26	5	2	--	--	--	19.31±0.94	

Table 10: The total, lower and upper gill raker counts of males and females of ***Caranx melampygus*** collected from the southern Red Sea of Egypt.

Total gill rakers (TGR)							
Counts	**25**	**26**	**27**	**28**	**29**	**mean±SD**	**T-value**
Males	8	14	36	11	2	26.79±0.94	-0.13
Females	5	13	26	5	4	26.81±1.00	
Upper gill rakers (UGR)							
Counts	**5**	**6**	**7**	**8**	**9**	**mean±SD**	**T-value**
Males	6	10	27	19	9	7.21±1.11	-0.92
Females	4	5	18	18	8	7.40±1.10	
Lower gill rakers (LGR)							
Counts	**17**	**18**	**19**	**20**	**21**	**mean±SD**	**T-value**
Males	4	9	14	30	14	19.58±1.12	0.80
Females	4	6	16	18	9	19.42±1.13	

Table 11: The dorsal fin rays, pectoral fin rays and anal fin rays counts of males and females of ***Carangoides bajad*** collected from the southern Red Sea of Egypt

Dorsal fin rays (DFR)									
Counts	**N**	**23**	**24**	**25**	**26**	**27**	**--**	**X±SD**	**T-value**
Males	102	3	37	26	24	12	--	25.05±1.09	-0.82
Females	83	3	31	14	17	18	--	25.19±1.25	
Pectoral fin rays (PFR)									
Counts	**N**	**16**	**17**	**18**	**19**	**20**	**--**	**X±SD**	**T-value**
Males	102	14	26	37	16	9	--	17.80±1.13	1.53
Females	83	23	13	30	13	4	--	17.54±1.19	
Anal rays (AFR)									
Counts	**N**	**20**	**21**	**22**	**23**	**24**	**25**	**X±SD**	**T-value**
Males	102	3	18	22	17	24	18	22.93±1.46	0.64
Females	83	4	13	19	19	16	12	22.80±1.43	

Table 12: The dorsal fin rays, pectoral fin rays and anal fin rays counts of males and females of ***Caranx melampygus*** collected from the southern Red Sea of Egypt

Dorsal fin rays (DFR)								
Counts	**N**	**21**	**22**	**23**	**24**	**25**	**X±SD**	**T-value**
Males	71	9	33	11	11	7	22.63±1.19	-0.97
Females	53	8	16	12	10	7	22.85±1.28	
Pectoral fin rays (PFR)								
Counts	**N**	**16**	**17**	**18**	**19**	**20**	**X±SD**	**T-value**
Males	71	14	22	18	13	4	17.59±1.17	-0.85
Females	53	8	16	13	12	4	17.77±1.19	
Anal fin rays (AFR)								
Counts	**N**	**17**	**18**	**19**	**20**	**--**	**X±SD**	**T-value**
Males	71	26	15	17	13	--	18.24±1.14	-1.98
Females	53	12	14	7	20	--	18.66±1.21	

5. Discussion

Morphometric indices of fishes were found to be of taxonomic importance in sex, race and species identification by many authors (Page and Braasch, 1976; Nelissen, 1978; Ezzat *et al*., 1979; Khalil *et al*., 1982; Mahmoud, 1991, 1993, 2002; Mekkawy and Mahmoud, 1992; Harabawy, 2002; Khan *et al*., 2002; Obady, 2003; Basmidi, 2004; Myers *et al*., 2004; Turan, 2004; Cadrin, 2005; Cheng *et al*., 2005; Ali and McNoon, 2010 Lawson, 2010; Simon *et al*.,2010; Elamin *et al*., 2011; Mekkawy and Mohammad, 2011; Mazlan *et al*., 2012; Deepti *et al*., 2013; Sajina *et al*., 2013; Jawad, 2015; Masood *et al*., 2015 and Zubia *et al*., 2015). In the present investigation, it was possible to reveal sexual dimorphism in *Carangoides bajad* and *Caranx melampygus* by comparing means of the selected morphometric indices.

The type of allometry was previously used to study sexual dimorphism in some fish species; *Mormyrus kannume* (Mekkawy, 1987) *Clarius lazera* (Mahmoud, 1988) *Labeo horie* and *lebeo forskalii* (Mahmoud, 1991), *Bagrus bayad* and *Bagrus docmac* (Mahmoud, 1993) and *Oreochromis mossambicus* (Oliveira and Almada, 1995). In the present study, it was possible to display sexual dimorphism according the type of allometry of the selected morphometric measurements.

Some investigators used meristic characters to reveal sexual dimorphism in different fish species comprising three *Synodontis* species from the Nile (Mahmoud and mekkawy, 1991) and *Labeo horie and Labeo forskalii* from the Nile (Mahmoud, 1991). No sexual dimorphism was observed in the meristics of each of *Carangoides bajad* and *Caranx melampygus* under investigation.

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