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Original Article

Study of some morphometric and meristic characteristics of *Alepes vari* (Cuvier, 1833) collected from the Arabian coast

Estudo de características morfométricas e merísticas de *Alepes vari* (Cuvier, 1833) coletados na costa da Arábia

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Abstract

The present study examines the correlations between fifteen morphometric and ten meristic characters and total length (TL) of males, females, and combined sexes of *Alepes vari* (Cuvier, 1833) collected from Karachi fish harbor, West Wharf of Karachi Coast. Statistical analyses of linear regression relationships show mostly strong correlations ($r \geq 0.70$; $p < 0.05$) between total length (TL) and most morphometric characters in males, females, and combined sexes, except the height of pectoral-fin (PFH), and pelvic-fin base length (PelFL); whereas, meristic characters were found to be constant and indicate weak or negative type correlations ($r \leq 0.50$; $p > 0.05$) with total length (TL). Hence, according to our present results, there is a direct relationship between the total length of fish and all morphometric characters, which were found to be the best indicators of positive allometric pattern growth in fish. Moreover, analysis of the 2-sample t-test revealed (t-test; $p > 0.05$) that no sexual dimorphism was reported in *Alepes vari*. Thus, our present study could be valuable in systematic classification, sexual dimorphism, and management of this species on the Karachi coast.

Keywords: morphometric, meristic characters, linear regression relationships, *Alepes vari*.

Resumo

O presente estudo examina as correlações entre 15 caracteres morfométricos e 10 caracteres merísticos e comprimento total (CT) de machos, fêmeas e sexos combinados de *Alepes vari* (Cuvier, 1833), coletados do porto de Karachi, West Wharf, na costa de Karachi. As análises estatísticas das relações de regressão linear mostraram, principalmente, correlações fortes ($r \geq 0{,}70$; $p < 0{,}05$) entre o CT e a maioria dos caracteres morfométricos em machos, fêmeas e sexos combinados, exceto a altura da nadadeira peitoral e o comprimento da base da nadadeira pélvica, enquanto os caracteres merísticos foram constantes, indicando correlações fracas ou negativas ($r \leq 0{,}50$; $p > 0{,}05$) com o CT. Portanto, de acordo com nossos resultados, existe uma relação direta entre o CT dos peixes e todos os caracteres morfométricos, que foram considerados os melhores indicadores de crescimento do padrão alométrico positivo em peixes. Além disso, a análise do teste t de duas amostras revelou (teste t; $p > 0{,}05$) que nenhum dimorfismo sexual foi relatado em *A. vari*. Assim, o presente estudo pode ser valioso na classificação sistemática, dimorfismo sexual e manejo dessa espécie na costa de Karachi.

Palavras-chave: morfométrica, caracteres merísticos, relações de regressão linear, *Alepes vari*.

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1. Introduction

Morphometric study plays a vital role in fish development pattern, habitat conditions, overall health, early life, feeding, fish fatness, development stage, gonad middle age, sexual category, size range, physical condition, and common fish form and maintenance (Jisr et al., 2018; Hassan et al., 2020a, b; Sabbir et al., 2020; Islam et al., 2020; Khatun et al., 2021). Morphological variables can be categorized into three main types including, i.e., (1) Positive allometry (+A), when the proportional morphological variable increases in relative to increment in total body length (TL); (2) Negative allometry (-A), when the proportional morphological variable decreases with increase in total body length (TL); (3) Isometry (I) when r-value is equal to 1.0, hence indicating a direct relationship between the morphological parameter and the total body length (TL); therefore, if the length is increased than the other body part also increases in equal rate accordingly (Ambily, 2017; Kamboj and Kamboj, 2019). The study of morphological characters of fishes is reasonably necessary for detecting the taxonomic classification of a genus or species and finding the differences between geographically variant populations. All such information can also be considered an initial step for studying ontogeny or evolutionary relationships of species (Langer et al., 2013; Prasad et al., 2020). Most researchers are now using DNA sequencing for distinguishing the evolutionary relationship among the different taxonomic groups. However, all such molecular studies need very high costs (Masood et al., 2015a, b). Therefore, the analysis of morphological characteristics of fish had been considered as the oldest method used for the study systematic of fish (Heinke, 1898). Moreover, morphological characters of fishes are mostly divided into two main categories, i.e., morphometric and meristic characters (Ambily, 2017). The word 'morphometry' is mainly used for the physical study of animals, while meristic is a word mostly used for counting characters of any organism, which can play a major role in observing the differences between fish populations belongs the same species occurs in different regions of the world (Groeger, 2000; Dars et al., 2012; Hassan et al., 2020b). All such differences might be produced because of variations in their sex, growth rates, habitat conditions, accessibility of foods, predator-prey interactions, and explain the evolutionary adaptations of any fish species (Masood et al., 2015a, b; Ambily, 2017). Furthermore, morphometric or meristic characters of fish can also explain the similarity or dissimilarity in various traits of male and female fishes either belonging to the same species. All such sexually dimorphic variations might be produced because of the variations in certain biological factors of fish (Masood et al., 2015b). Morphometric characters are affected mainly by several environmental factors, especially during the juvenile's stage or sexual maturity stages of fish during the breeding season (Adeoye et al., 2016; Akter et al., 2019).

Fishes belonging to Carangidae are commonly known as 'jacks', 'pompanos', and 'scad'. Nelson (1984) described 32 genera and 140 species of the family Carangidae. Bianchi (1985) also studied 19 genera and 42 species of the family Carangidae on the Pakistan coast. As these are tropical marine fishes, therefore have great economic importance, particularly for recreation and aquaculture purposes (Romanova et al., 2018; Hussain et al., 2021; Hassan et al., 2021a, b). *Alepes* is an abundantly found genus of this family. Word "*Alepes*" is derived from the Greek word "*alepis*" which means "without scales" (Romero, 2002). *Alepes vari* belongs to this genus is a tropically marine species commonly known as "Herring scad" (Hosese et al., 2007). This species is widely distributed in the Indo-West Pacific Ocean, growing up to 56 cm in total body length, but their average size is 30 cm in TL (Romero, 2002). *Alepes vari* is locally known as, Bangra, Seem, Kakaan, and Pattar along the Pakistan coast (Bianchi (1985). These are large pelagic fishes that swim in-depth from zero to 10 meters near the surface of coastal water and feed on shrimps, copepods, decapods, and small fishes (Froese and Pauly, 2016; Nelson et al., 2016). As no previous study had been done on all selected morphometric and meristic characters of *Alepes vari* along the Pakistan coast, therefore present study was primarily attempts to examine the growth patterns of various body parts of this species with total body length (TL) and also observe sexual dimorphic morphological variations of this species that have potential value in fisheries management.

2. Materials and Methods

2.1. Ethical statement

This study was carried out with the strict commendations and approval of the Ethical Committee for Experiments on Fisheries of the University of Karachi and SBK Women University Quetta, Baluchistan, Pakistan

2.2. Study area

Fish samples were gathered from Karachi fish harbour, West Wharf at Karachi coast located at 24° 48 N latitude, and 66° 58 E longitudes on the North-eastern border of the Arabian Sea.

2.3. Fish sampling

A total of 100 species of *Alepes vari* includes 56 males and 44 females, were collected in this study from January to December 2019. All specimens were transported to the laboratory in polythene bags containing ice blocks to prevent spoilage before analysis.

2.4. Morphometric measurements and meristic counts

Fifteen morphometric and ten meristic characters were analyzed in this study with standard procedures as previously followed by Dwivedi and Menezes (1974), Masood et al. (2015a, b) and Prasad et al. (2020). All these morphological parameters were represented along with their acronyms in Table 1 and Figure 1, respectively. The values of mean, range, standard deviation, and standard error of each morphometric or meristic character of males, females, and combined sexes were presented in Table 2a, respectively.

Table 1. Quantitative morphometric and meristic characters used for differentiation analysis of *Alepes vari* collected from Karachi coast.

Morphometric Characters	Acronyms
1. Total body length	TL
2. Forked length	FL
3. Standard length	SL
4. Head length	HL
5. Body depth	D
6. First dorsal-fin height	D1H
7. First dorsal-fin base length	D1L
8. Pectoral-fin base length	PFL
9. Pectoral fin height	PFH
10. Pelvic-fin height	PelFH
11. Pelvic-fin base length	PelFL
12. Anal-fin height	AFH
13. Anal-fin base length	AFL
14. Pre-dorsal length	PDL
15. Eye diameter	Ed
Meristic characters	**Acronyms**
1. Number of scutes on straight section of lateral line	SLL
2. Number of spines in first dorsal fin	DFS1
3. Number of soft rays in second dorsal fin	DFSR2
4. Number of spines of pectoral fin	PFS
5. Number of soft rays of pectoral fin	PFSR
6. Number of spines of anal fins	AFS
7. Number of soft rays of anal fin	AFSR
8. Number of spines of pelvic fin	PelFS
9. Number of soft rays of pelvic fin	PelFSR
10. Number of gill rakers	GR

Linear regression relationship equation was applied to determine the relationships between total body length versus morphometric or meristic parameter of this study as follow;

$$Y = bX \pm a$$

whereas, "Y" represents the morphological parameter and "X" represent the total body length of fish measured in millimeters, whereas, 'a' was a constant value and 'b' was the regression coefficient, The range, mean, standard deviations, correlation coefficient 'r' and t-test at 5% significant ($p<0.05$) were also calculated as previously followed by Ambily (2017). Moreover, a 2-sample t-test at 95% confidence interval (CI) when $p<0.05$ was calculated by using statistical Minitab software (version 17.1) for observing the sexually dimorphic morphological variations between males and females of *Alepes vari* with method followed by Masood et al. (2015b).

3. Results and Discussion

3.1. Morphometric and meristic characteristics of Alepes vari (Cuvier, 1833)

In this study, the external morphology of the fish body was observed as strongly compressed with ventral and dorsal profiles are in convex shapes that unite anteriorly to form a pointed snout. The body contains two dorsal fins, one pectoral and pelvic fin, an anal fin, and a forked caudal fin. The spiny dorsal fin includes 7-9 spines, the second dorsal fin includes 21-24 soft-rays; the pectoral fin contains 17-24 soft-rays; the anal fin has 1-3 spines and 17-20 soft-rays; the pelvic fin includes 2-5 soft-rays, the number of gill rakers ranged from 37-47 and the number of scutes was 48-62 on lateral line, respectively. Although morphometric measurements of the current study disclose that total body length (TL) were found in a range from 135 to 352 mm, forked length (FL) ranged

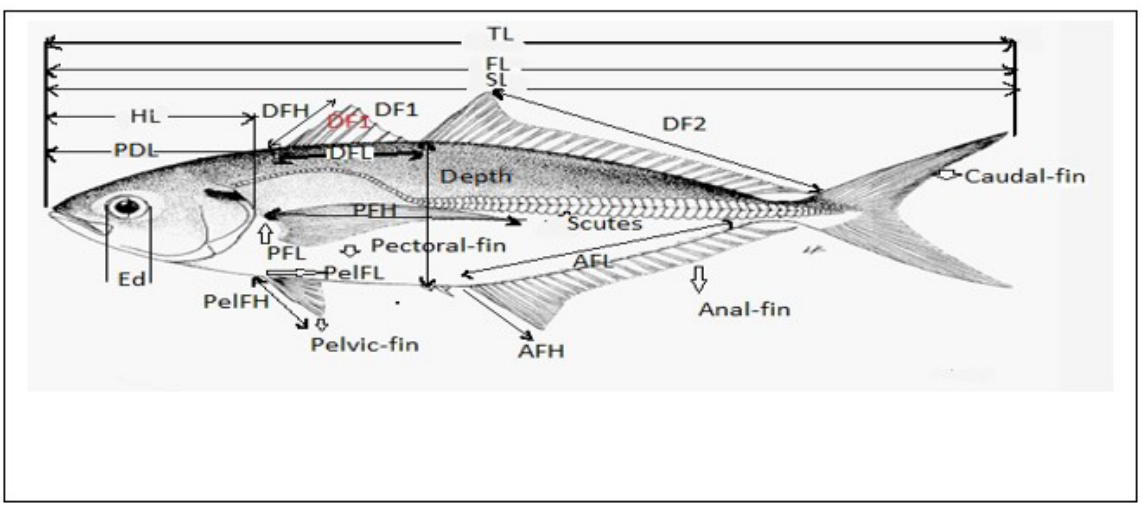

Figure 1. Measurements of morphometric characters of fish.

Table 2a. Mean, standard deviation, standard error of mean, minimum and maximum value of morphometric and meristic traits of male, female, combined sexes of *Alepes vari* at Karachi coast.

Variables	Combined sexes (N=100)				Males (N=56)				Females (N=44)			
	Mean±S.D	S.E of Mean	Range		Mean±S.D	S.E of Mean	Range		Mean±S.D	S.E of Mean	Range	
			Min.	Max.			Min.	Max.			Min.	Max.
Morphometric												
TL	258.9±42.4	4.24	135.0	352.0	262.9± 40.5	5.42	192.0	352.0	253.9 ±44.6	6.73	135.0	341.0
FL	224.3 ±36.8	3.68	118.0	296.0	226.5±37.1	4.95	118.0	296.0	221.4±36.7	5.54	165.0	296.0
SL	184.3±32.1	3.21	104.0	250.0	187.2 ±30.1	4.03	138.0	245.0	180.5±34.3	5.18	104.0	250.0
HL	51.5 ±8.1	0.81	38.0	69.0	51.9 ±7.8	1.05	40.0	6 7.00	51.1±8.4	1.27	38.0	69.0
D	77.6 ±11.6	1.17	54.0	107.0	78.6±11.4	1.53	61.0	107.0	76.5±12.0	1.81	54.0	105.0
D1H	23.3 ±4.1	0.41	15.0	30.0	23.2±3.8	0.51	15.0	30.0	23.4±4.5	0.68	17.0	30.0
D1L	29.0±4.9	0.49	14.0	40.0	28.8 ±5.1	0.68	14.0	40.0	29.2±4.7	0.72	20.0	39.0
PFH	13.4 ±4.7	0.47	9.0	55.0	13.7 ±5.9	0.79	10.0	55.0	12.9 ±2.4	0.37	9.0	20.0
PFL	63.8±12.5	1.25	26.0	92.0	66.0 ±11.8	1.58	45.0	92.0	61.0 ±13.0	1.96	26.0	89.0
PelFH	23.2 ±5.6	0.56	12.0	35.0	24.1±5.5	0.74	12.0	35.0	22.0±5.6	0.84	13.0	33.0
PelFL	7.5 ±1.7	0.17	4.0	12.0	7.5±1.4	0.19	4.0	11.0	7.5±2.0	0.30	5.0	12.0
AFH	25.8 ±4.3	0.43	17.0	38.0	26.3±4.2	0.56	17.0	38.0	25.2±4.3	0.66	19.0	34.0
AFL	79.8±12.7	1.27	56.0	110.0	81.0 ±12.3	1.64	61.0	110.0	78.4±13.2	2.00	56.0	109.0
PDL	72.3 ±11.6	1.16	51.0	99.0	73.4±10.9	1.46	55.0	96.0	71.1±12.4	1.88	51.0	99.0
Ed	10.5 ±1.5	0.15	7.0	15.0	10.5±1.5	0.21	7.0	14.0	10.6±1.4	0.22	8.0	15.0
Meristic												
SLL	47.7 ±1.6	0.16	48.0	62.0	47.7±1.6	0.22	48.0	62.0	47.7±1.7	0.27	48.0	62.0
DFS1	6.8 ±0.4	0.04	7.0	9.0	6.8±0.4	0.05	7.0	9.0	6.9±0.5	0.08	7.0	9.0
DFSR2	22.6 ±0.8	0.08	21.0	24.0	22.7±0.7	0.09	21.0	24.0	22.5±0.9	0.15	21.0	24.0
PFS	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0
PFSR	21.5 ±1.3	0.13	17.0	24.0	21.5±1.1	0.16	17.0	23.0	21.5 ±1.4	0.22	18.0	24.0
AFS	2.0 ±0.2	0.02	1.0	3.0	2.0±0.3	0.04	1.0	3.0	2.0±0.2	0.03	1.0	3.0
AFSR	18.8 ±0.6	0.06	17.0	20.0	18.9±0.6	0.08	17.0	20.0	18.7±0.7	0.11	17.0	20.0
PelFS	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0
PelFSR	4.0 ±0.3	0.03	2.0	5.0	4.0±0.4	0.05	2.0	5.0	4.0±0.2	0.04	4.0	5.0
GR	41.6 ±1.6	0.16	37.0	47.0	41.6±1.6	0.22	37.0	47.0	41.7±1.5	0.24	37.0	47.0

Note: N = number of samples; S.D= standard deviation; S.E = standard error of mean.

from 118 to 296 mm, standard length (SL) was between 104 to 250mm, head length (HL) varies from 38 to 69 mm, body depth (D) ranged from 54 to 107 mm, first dorsal-fin height (D1H) ranged from 15 to 30 mm, first dorsal-fin length (D1L) varies from 14 to 40 mm, pectoral-fin height (PFH) ranged from 9.0 to 55mm, pectoral-fin length (PFL) varies from 26 to 92 mm, pelvic-fin height (PelFH) ranging from 12 to 35 mm, pelvic-fin length (PelFL) was between 4.0 to 12mm, anal-fin height varies from 17 to 38, anal-fin length ranged from 56 to 110mm, pre-dorsal length (PDL) ranging from 51 to 99 mm, and eye diameter was ranged from 7.0 to 15.0mm, as shown in Table 2a respectively. Above mention results were found to be similar as previously described by Al-Faisal et al. (2015) and Roul et al. (2017), which might be because of their exact geographical location, ecological conditions, or human activities like fishing in their particular habitats, as stated by Fakunmoju et al. (2014).

3.2. Sexual dimorphism

Both morphometric and meristic characteristics of males and females of this species showed consistency with each other, as presented in Table 2b, respectively. Therefore, this study revealed that there is only little variations (t-test; $p>0.05$) were found to occur between all morphometric and meristic characteristics of male and female fishes of *Alepes vari,* except the pectoral-fin base length (PFL) that shows a significant variation (t-test; $p<0.05$). Hence, no sexual dimorphism was reported in this species. Carpenter and Niem (2001) stated that *Alepes vari* can be identified from the other genus *Alepes* based on two significant meristic traits, i.e., number of scutes on its lateral line and the number of gill rakers on its first-gill arch. Moreover, sexual dimorphism can be characterized by the amount of dark pigment present in the dorsal fins, anal fins, and pelvic fins compared to females of this species. Tarique et al. (1977) and Begum et al. (2008) had also observed the sexual dimorphism based on some morphometric traits for carp fish species *Labeo calbasu,* and catfish species *Mystus gulio.* Hence, the analysis of meristic and morphometric variations between male and female fishes of a particular species could also be considered a valuable tool in determining sexual dimorphism (Adarsh and James, 2016).

3.3. Linear regression relationships between total body length (TL) and morphological characters of Alepes vari

As fish morphometric characters usually refer to the measuring of total body length of fish with various other body parts of its anatomy; therefore, accordance to Marr (1955), Hoque (1984), and Chaklader et al. (2006), a study of linear regression relationships between total body length of fish and several morphometric characters were found to be the best indicator for detecting the growth pattern of fish. The overall findings of linear regression relationships between total body length (TL) and all morphometric characters of males, females, and combined sexes of *Alepes vari* reveals strong and significant correlations ($r>0.70$; $p<0.05$) except the pectoral-fin height (PFH) and pelvic-fin length (PelFL) that accessible a very weak or moderate type of correlation, as obtainable in Tables 3a, 4a and 5a respectively. Hence, the results of morphometric characters show a positive allometric growth pattern (A+), which reveals the direct relationship between total body length and growth of various body parts of this species, which was following Hoque (1984), Begum et al. (2008) and Saroniya et al. (2013). However, some workers like Marr (1955) and Tandon (1962) have also observed no significant relationships ($p>0.05$) between various morphometric characters with the total body length of fish. This might be because the ratio of increase in different morphometric characters with a complete body length from larval to adult stages may not always show similar consistency in their growth rates. Moreover, there are no significant variations were observed in linear relationships between total body length and all selected morphometric characters for males, females of *Alepes vari* of this study, which was in harmony with Begum et al. (2008) and Saroniya et al. (2013), who also found homogeneity in growth rates of various morphometric traits of males and females of *Mystus gulio*, *Puntius chola* and *Puntius sophore* with increment in total body length. Whereas, Tiwari and Qureshi (2003) had also observed the heterogeneity in growth rates of various morphometric traits of males and females of *Rita pavimentata* with total length and found slightly faster growth rates in some morphometric characters of females than males, which might be due to variations in their physiological activities. Sometimes, variations in morphometric characters can also be considered an indicator of water pollution (Singla, 2017). Therefore, morphometric measurement can be considered a vital tool to discriminate any fish species found in various habitats than meristic counts, as Yusuf and Ali (2009) observed.

Meristic characters showed heterogeneity in the current study, exhibiting both weakly positive and negative types of correlations (when r 0.50, $p>0.05$) with total body length (TL) for males, females, and combined sexes of *Alepes vari*, as shown in Tables 3b, 4b, and 5b, respectively, which was reliable with Brraich and Akhter (2015), indicating that there are no direct relationships between total body length and various meristic characters. Furthermore, the study of relationships between various meristic characters and total body length in males and females of *Alepes vari* showed homogeneity, which might be because meristic characters remain fixed during the whole life of both sexes, as reported by Masood et al. (2015a) and Ambily (2017). However, great variations in such relationships have also been reported in some fish species i.e., *Nematalosa nasus*, *Pterophyllum scalare*, and *Crossocheilus latius latius* by Al-Hassan (1987), Koshy et al. (2008), and Brraich and Akhter (2015), which might because of variations in geographical locations and considerable impact of abiotic factors (depth, turbidity, and temperature of water) or biotic factors (population size, fish growth, genetic features) of habitat on meristic characteristics of a fish species occurs in different regions of the world, as previously reported by Hasan et al. (2021), Ezeafulukwe et al. (2015), Ramasamy and Rajangam (2016) and Prasad et al. (2020).

Table 2b. Sample t-test at 95% confidence interval (CI) for morphological traits of male, female, combined sexes of *Alepes vari* at Karachi coast.

Variables	Male (N=56)				Females (N=44)				2-sample t-test at 95% Confidence Interval (CI)			
	Mean±S.D	S.E of Mean	Range		Mean±S.D	S.E of Mean	Range		t-test	p-value	Confidence Interval	
			Min.	Max.			Min.	Max.			(CI) 95%	
Morphometric												
TL	262.9± 40.5	5.42	192.0	352.0	253.9 ±44.6	6.73	135.0	341.0	1.05	0.30^{NS}	-7.95	25.93
FL	226.5±37.1	4.95	118.0	296.0	221.4±36.7	5.54	165.0	296.0	0.68	0.50 ^{NS}	-9.67	19.85
SL	187.2 ±30.1	4.03	138.0	245.0	180.5±34.3	5.18	104.0	250.0	1.03	0.31 ^{NS}	-6.18	19.45
HL	51.9 ±7.8	1.05	40.0	6 7.00	51.1±8.4	1.27	38.0	69.0	0.44	0.66 ^{NS}	-2.52	3.98
D	78.6±11.4	1.53	61.0	107.0	76.5±12.0	1.81	54.0	105.0	0.88	0.38 ^{NS}	-2.59	6.76
D1H	23.2±3.8	0.51	15.0	30.0	23.4±4.5	0.68	17.0	30.0	-0.15	0.88 ^{NS}	-1.78	1.54
D1L	28.8 ±5.1	0.68	14.0	40.0	29.2±4.7	0.72	20.0	39.0	-0.33	0.74 ^{NS}	-2.32	1.66
PFH	13.7 ±5.9	0.79	10.0	55.0	12.9 ±2.4	0.37	9.0	20.0	0.79	0.43 ^{NS}	-1.14	2.65
PFL	66.0 ±11.8	1.58	45.0	92.0	61.0 ±13.0	1.96	26.0	89.0	2.00	**0.05**α	0.03	9.90
PelFH	24.1±5.5	0.74	12.0	35.0	22.0±5.6	0.84	13.0	33.0	1.81	0.07 ^{NS}	-0.19	4.24
PelFL	7.5±1.4	0.19	4.0	11.0	7.5±2.0	0.30	5.0	12.0	-0.04	0.97 ^{NS}	-0.69	0.66
AFH	26.3±4.2	0.56	17.0	38.0	25.2±4.3	0.66	19.0	34.0	1.35	0.18 ^{NS}	-0.55	2.86
AFL	81.0 ±12.3	1.64	61.0	110.0	78.4±13.2	2.00	56.0	109.0	1.02	0.31 ^{NS}	-2.47	7.69
PDL	73.4±10.9	1.46	55.0	96.0	71.1±12.4	1.88	51.0	99.0	0.96	0.34 ^{NS}	-2.40	6.89
Ed	10.5±1.5	0.21	7.0	14.0	10.6±1.4	0.22	8.0	15.0	-0.53	0.60 ^{NS}	-0.76	0.44
Meristic												
SLL	47.7±1.6	0.22	48.0	62.0	47.7±1.7	0.27	48.0	62.0	-0.05	0.96 ^{NS}	-0.69	0.66
DFS1	6.8±0.4	0.05	7.0	9.0	6.9±0.5	0.08	7.0	9.0	-0.31	0.76 ^{NS}	-0.18	0.13
DFSR2	22.7±0.7	0.09	21.0	24.0	22.5±0.9	0.15	21.0	24.0	0.87	0.39 ^{NS}	-0.19	0.48
PFS	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00
PFSR	21.5±1.1	0.16	17.0	23.0	21.5 ±1.4	0.22	18.0	24.0	0.34	0.74 ^{NS}	-0.44	0.61
AFS	2.0±0.3	0.04	1.0	3.0	2.0±0.2	0.03	1.0	3.0	1.30	0.20 ^{NS}	-0.03	0.15
AFSR	18.9±0.6	0.08	17.0	20.0	18.7±0.7	0.11	17.0	20.0	1.18	0.24 ^{NS}	-0.11	0.43
PelFS	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00
PelFSR	4.0±0.4	0.05	2.0	5.0	4.0±0.2	0.04	4.0	5.0	-0.72	0.47 ^{NS}	-0.19	0.09
GR	41.6±1.6	0.22	37.0	47.0	41.7±1.5	0.24	37.0	47.0	-0.24	0.81 ^{NS}	-0.73	0.57

Note: N = number of samples; S.D = standard deviation; S.E = standard error of mean; ^{NS} represents the insignificant variation (2- sample t-test; p>0.05); while α represents significant variation (when 2-sample t-test; p<0.05).

Table 3a. Linear regression relationship between total body length (TL) and different morphometric characters for male *Alepes vari*. Total length and all other variables are taken in mm. (N=56).

Total length	Morphometric characters	Regression coefficients			t-test at 5% significant (p<0.05)			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	FL	-3.94	0.87	0.95	0.03	0.00α	24.72	***
TL	SL	0.88	0.70	0.95	0.03	0.00α	23.07	***
TL	HL	2.81	0.18	0.95	0.00	0.00α	24.90	***
TL	D	8.29	0.26	0.94	0.01	0.00α	21.57	***
TL	D1H	3.12	0.07	0.80	0.00	0.00α	10.11	***
TL	D1L	-0.06	0.11	0.87	0.00	0.00α	13.06	***
TL	PFL	-5.13	0.27	0.92	0.01	0.00α	18.52	***
TL	PFH	4.52	0.03	0.23	0.01	0.07♣	1.81	*
TL	PelFH	-4.62	0.10	0.80	0.01	0.00α	9.85	***
TL	PelFL	2.89	0.01	0.50	0.00	0.00α	4.35	*
TL	AFH	3.68	0.08	0.83	0.00	0.00α	11.26	***
TL	AFL	3.30	0.29	0.97	0.00	0.00α	32.53	***
TL	PDL	3.95	0.26	0.97	0.00	0.00α	34.11	***
TL	Ed	3.27	0.02	0.71	0.00	0.00α	7.61	***

Note: N = number of fish samples; S.E = standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; α shows significant correlation when p<0.05.

Table 3b. Linear regression relationship between total body length (TL) and different meristic characters for male *Alepes vari*. Total length and all other variables are taken in mm. (N=56).

Total length in mm	Meristic characters	Regression coefficients			t-test at 5% significant (p<0.05)			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	SLL	47.2	0.00	-0.04	0.00	0.72♣	-0.36	-
TL	DFS1	6.94	-0.00	-0.04	0.00	0.76♣	-0.30	-
TL	DFSR2	22.8	-0.00	-0.01	0.00	0.89♣	-0.13	-
TL	PFS	0.0	0.00	0.00	0.00	0.00	0.0	0
TL	PFSR	19.6	0.00	0.12	0.00	0.35♣	0.94	*
TL	AFS	1.94	0.00	0.05	0.00	0.68♣	0.41	*
TL	AFSR	18.9	0.00	0.01	0.00	0.93♣	0.08	*
TL	PelFS	0.0	0.00	0.00	0.00	0.00	0.00	0
TL	PelFSR	3.93	0.00	0.03	0.00	0.80♣	0.25	*
TL	GR	41.4	0.00	0.02	0.00	0.86♣	0.17	*

***Note**: N = number of fish samples; S.E = standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; □ shows significant correlation when p<0.05.

Table 4a. Linear regression association between total body length (TL) and various morphometric characters for female *Alepes vari*. Total length and all other measurements are in mm. (N=44).

Total length	Morphometric characters	Regression coefficients			t-test at 5% significant (p<0.05)			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	FL	28.6	0.75	0.92	0.04	0.00α	15.41	***
TL	SL	-8.68	0.74	0.96	0.02	0.00 α	24.95	***
TL	HL	6.10	0.17	0.93	0.01	0.00 α	17.61	***
TL	D	17.0	0.23	0.87	0.02	0.00 α	11.49	***
TL	D1H	2.03	0.08	0.83	0.00	0.00 α	9.73	***
TL	D1L	5.39	0.09	0.87	0.00	0.00 α	11.89	***
TL	PFL	1.86	0.23	0.80	0.02	0.00 α	8.64	***
TL	PFH	3.68	0.03	0.67	0.00	0.00 α	5.87	**
TL	PelFH	-3.33	0.09	0.79	0.01	0.00 α	8.57	***
TL	PelFL	1.20	0.02	0.55	0.00	0.00 α	4.36	*
TL	AFH	4.39	0.08	0.84	0.00	0.00 α	10.09	***
TL	AFL	9.78	0.27	0.91	0.01	0.00 α	14.29	***
TL	PDL	7.06	0.25	0.90	0.01	0.00 α	13.79	***
TL	Ed	4.36	0.02	0.77	0.00	0.00 α	793	***

***Note**: N = number of fish samples; S.E= standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; α shows significant correlation when p<0.05.

Table 4b. Linear regression association between total body length (TL) and various meristic characters for female *Alepes vari*. Total length and all other measurements are in mm. (N=44).

Total length	Meristic characters	Regression coefficients			t-test at 5% significance			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	SLL	46.4	0.00	0.03	0.00	0.82♣	0.22	*
TL	DFS1	17.70	- 0.00	-0.26	0.00	0.07♣	-1.81	-
TL	DFSR2	222.4	0.00	0.04	0.00	0.79♣	0.26	*
TL	PFS	0.00	0.00	0.00	0.00	0.00	0.00	0
TL	PFSR	18.5	0.00	0.24	0.00	0.11♣	1.60	*
TL	AFS	1.95	0.00	0.04	0.00	0.79♣	0.27	*
TL	AFSR	16.7	0.00	0.48	0.00	0.00□	3.57	*
TL	PelFS	0.00	0.00	0.00	0.00	0.00	0.00	0
TL	PelFSR	4.22	- 0.00	-0.10	0.00	0.49♣	-0.69	-
TL	GR	40.4	0.00	0.14	0.00	0.36♣	0.92	*

***Note**: N = number of fish samples; S.E= standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; α shows significant correlation when p<0.05.

Table 5a. Linear regression relationship between total body length (TL) and various morphometric characters for combined sexes of *Alepes vari*. Total length and all other measurements are in mm. (N=100).

Total length	Morphometric characters	Regression coefficients			t-test at 5% significant (p<0.05)			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	FL	12.8	0.81	0.94	0.02	0.00 α	27.31	***
TL	SL	- 3.88	0.72	0.96	0.02	0.00 α	34.2	***
TL	HL	4.68	0.18	0.94	0.00	0.00 α	29.36	***
TL	D	12.7	0.25	0.91	0.01	0.00 α	21.89	***
TL	D1H	2.81	0.07	0.81	0.00	0.00 α	13.87	***
TL	D1L	2.97	0.10	0.86	0.00	0.00 α	16.88	***
TL	PFL	- 2.39	0.25	0.86	0.01	0.00 α	17.10	***
TL	PFH	3.99	0.03	0.32	0.01	0.00 α	3.42	*
TL	PelFH	- 4.27	0.10	0.80	0.00	0.00 α	13.0	***
TL	PelFL	2.11	0.02	0.52	0.00	0.00 α	6.16	**
TL	AFH	3.87	0.08	0.84	0.00	0.00 α	15.38	***
TL	AFL	6.49	0.28	0.94	0.00	0.00 α	28.56	***
TL	PDL	5.51	0.25	0.94	0.00	0.00 α	27.82	***
TL	Ed	3.92	0.02	0.73	0.00	0.00 α	10.57	***

***Note**: N = number of fish samples; S.E= standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; α shows significant correlation when p<0.05.

Table 5b. Linear regression relationship between total body length (TL) and various meristic characters for combined sexes of *Alepes vari*. Total length and all other measurements are in mm. (N=100).

Total length	Meristic characters	Regression coefficients			t-test at 5% significance			Correlation type
X	Y	a	b	r	S.E	p-value	t-test	CT
TL	SLL	46.8	- 0.00	-0.00	0.00	0.92♣	-0.09	-
TL	DFS1	17.33	- 0.00	-0.17	0.00	0.08♣	-1.73	-
TL	DFSR2	222.5	0.00	0.02	0.00	0.83♣	0.21	*
TL	PFS	0.00	0.00	0.00	0.00	0.00	0.00	0
TL	PFSR	19.1	0.00	0.18	0.00	0.06♣	1.89	*
TL	AFS	1.94	0.00	0.05	0.00	0.57♣	0.56	*
TL	AFSR	17.8	0.00	0.26	0.00	0.00α	2.69	*
TL	PelFS	0.00	0.00	0.00	0.00	0.00	0.00	0
TL	PelFSR	4.09	- 0.00	-0.02	0.00	0.82♣	-0.22	-
TL	GR	40.9	0.00	0.07	0.00	0.47♣	0.72	*

Note: N = number of samples; S.E = standard Error; CT = correlation type; *** shows the strong correlation (r > 0.70); ** shows moderate correlation (r = 0.51-0.69); * represent weak correlation (r < 0.50); – shows negative correlation; ♣ shows insignificant correlation when p>0.05; α shows significant correlation when p<0.05.

4. Conclusions

Thus, our present study of different morphometric measurements and meristic counts can also be used to differentiate the external changes, ontogenic associations, and true recognition of an organism. Moreover, this technique has now widely been used to protect endangered fish species and explain the effect of various environmental factors on growth in fish.

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