

Biometric Study of Yellow Striped Goat Fish *Upeneus vittatus* (Forsskal, 1775) from Andaman and Nicobar Islands, India

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Abstract

10 specimens of Yellow striped goatfish, *Upeneus vittatus* (Forsskal, 1775) collected on 2nd April 2022 and 10th April 2022 from Junglighat landing center of Andaman and Nicobar group of Islands, were studied. The size ranged from 126.5-232.3 mm in total length and 23.31-135.8g in total weight. 29 morphometric and 13 meristic characters were considered for the current study. In analyzing percentage of standard length, 19 morphometric characters were considered and for percentage of head length 8 characters were considered. Regressions of standard length, head length, pre-dorsal length, pre-pectoral length, pre-ventral length, pre-anal length, pectoral fin length, caudal fin length and body depth, against total length and that of snout length, post-orbital length, eye diameter and inter-orbital length, against the head length were analyzed. From these fourteen counts, coefficient of correlation (r) was maximum for head length against post orbital length (0.996) and lowest for total length against pectoral fin length (0.938). Descriptive meristic counts were found to be in agreement with previous descriptions. Based on the results from the current work, the fin formula for *U. vittatus* could be written as: $P_{14-16} V_{1.5} D_{VIII,8-9} C_{13} A_{1,7}$.

Key words: *Upeneus vittatus*, Biometric, morphometrics and meristics, Andaman and Nicobar Islands.

Introduction

Mullidae, also known as The Goatfish or red mullets, are a tropical marine Mulliformes fish (Randall, 2004; Froese and Pauly, 2022). They can be found in tropical and subtropical part of the Pacific, Indo-pacific and Western Atlantic Regions, and represent important food-chain for coastal environment (Pavlov et al., 2015). This fish generally benthivores; occurs in open muddy or sandy bottom or in vicinity of reef in brackish or marine water (Hiatt and Strasburg, 1960; Hobson, 1974; Munro, 1976; Holland et al., 1993; Meyer et al., 2000; Randall and Kulbicki, 2006; Uiblein and Gouws, 2015). There are 6 valid genera and 104 species of the family Mullidae known worldwide (Fricke et al., 2022) and the genus *Upeneus* dominates over other genera with 46 species (Froese, 2022). There are 3 genera and 27 species known from India (Joshi et al., 2017). In Andaman and Nicobar Islands, there are 18 Mullidae species which are from 3 genera; out of which 5 species are from the genus *Upeneus* (Rajan et al., 2021).

Their body deep and elongated, and a pair of long chemosensory barbels (whiskers) is present, which is

used in searching for meal. By probing with their barbels and by using mouth to burrow sediments, they hunt for epibenthic and sub surface prey (Randall, 1967; Gosline, 1984). Some distinctive morphological features of Family Mullidae are, presence of two dorsal fin, chin barbels, villiform teeth, oblique bars on caudal fin and lateral stripes on the body (Kathirvelpandian et al., 2021).

Yellow strip goatfish *Upeneus vittatus*, a species of Mullidae family which is found in Indian Ocean is a commercially important fish. These fishes are euryhaline, benthopelagic in nature (Lewis and Pring, 1986; Mundy, 2005). Their preferred diet consists of crustaceans, such as penaeid shrimps, crabs and small fishes (Vivekanandan et al., 2003). *U. vittatus* is less elongate in shape. The depth is around 3.3 to 3.7 times in standard length. Their chin consists of 2 barbels, which are not extended to preopercle. It has a length of 1.5 to 2.2 in head length. Mouth contains villiform teeth in jaws on the roof. Pelvic fins nearly 2/3 length of pectoral fins (Barman and Mishra, 2007). The length of the pelvic fin is short, almost two-third of the pectoral fin. The upper caudal fin lobe with 4-5 bands; 3-4 dark bands stripe on the lower lobe and the

darkest and broadest is the distal one (Barman and Mishra, 2007).

Morphometric analysis can be helpful in evaluation of population structure and stock variability in shape and size in a stock (CadrinandFriedland, 1999; Turan, 2004). However, there is no record of detailed study on morphological traits of *Upeneus vittatus* from Andaman waters even though this species contributes largely in marine fish catch composition along Andaman coast. Hence, an attempt has been made to investigate the morphometrics and meristics of *U. vittatus* from this region.

Materials and method

The sampling was conducted on 2nd April 2022 and 10th April 2022 from Junglighat (11°66'12" N, 92.7295° E) landing center of South Andaman. The fish samples were caught from Swaraj Dweep Island (11.9761° N, 92.9876° E), the coast of Andaman and Nicobar group of Islands. 10 specimen of *U. vittatus* were collected and identified with identification keys (FAO, 1983a). Photograph of the specimen was taken by Nikon D5300 along with a scale next to the sample. The specimen was preserved in deep freezer prior to analysis. For morphometric analysis, Vernier Caliper was used to measure the fish and the measurements were taken to the nearest 0.01mm.

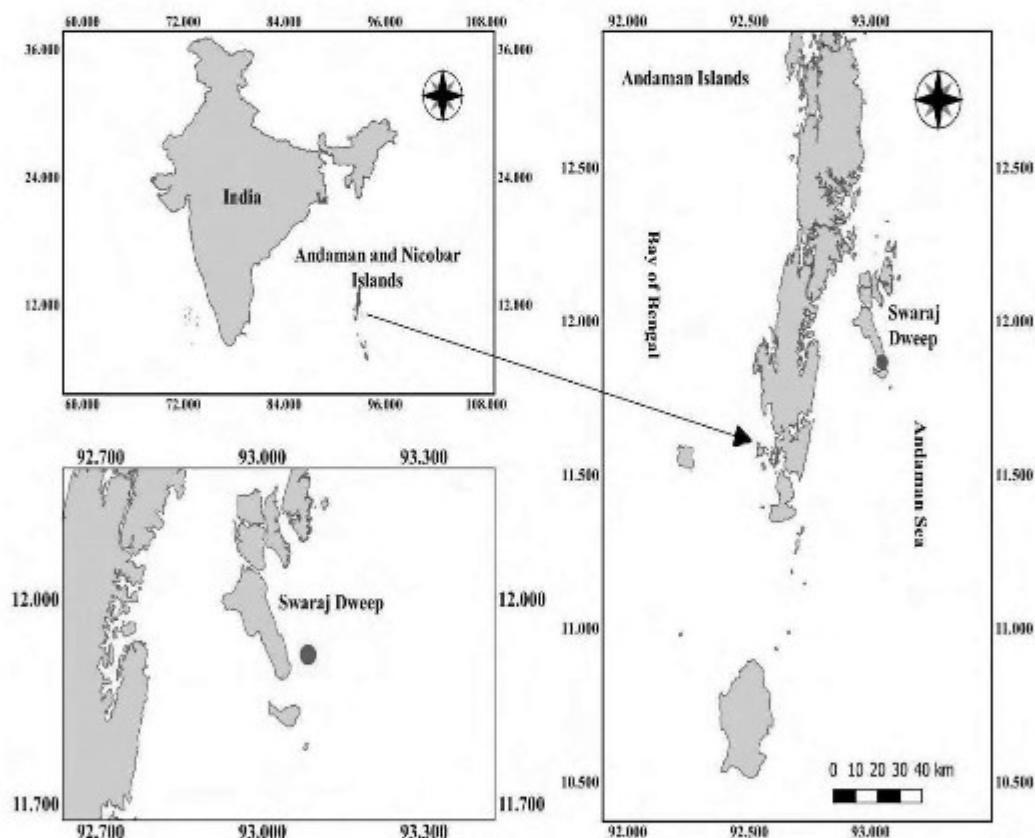


Fig. 1: Study area from Andaman and Nicobar Islands

13 meristic characters and 29 morphometric characters were recorded for the study. For meristic; Dorsal fin spine, Dorsal fin rays, Anal spine, Anal Fin Rays, Caudal Fin Rays, Pectoral Fin Rays, Scale row above lateral line, Ventral (Pelvic) fin spine, Ventral fin rays, Lateral line

scale, Scale row below lateral line, Upper Gill Rakers and Lower Gill Rakers have been considered. While for Morphometric; Total Length TL, Standard Length SL, Fork Length FL, Head Length HL, Head Width HW, Head Depth HD, Eye Diameter ED, Inter Orbital Length

IOL, Snout Length SnL, Post Orbital Length POL, Upper Jaw Length UJL, Lower Jaw Length LJL, Body Depth BD, Pre- Pectoral Length PPL, Pectoral Fin Length PFL, Pectoral Base Length PBL, Pre- Ventral Length PVL, Ventral Fin Length VFL, Ventral Base Length VBL, Pre-Dorsal Length PDL, Dorsal Fin Length DFL, Dorsal Base Length DBL (DBL1 & DBL2), Pre- Anal Fin Length PAFL, Anal Fin Length AFL, Anal Fin Base Length AFBL, Caudal Peduncle Length CPL, Caudal Peduncle Depth CPD and Caudal Fin Length CFL, has been considered. After the analysis, specimen was tagged with date it was preserved in deep freeze at -20°C or in 10% formalin solution.

By using % in Standard Length and % in head length, the mean \pm standard deviation of morphometric data has been calculated up to two decimal point. The relationship between several morphometric measurements to the total length and head length have been analyzed (Shah et al., 2014). The morphometric characters were depicted with the help of scattergrams and then they were plotted (Figure 5 & Figure 6). Linear regression applying the least square method described by Snedecor and Cochran (1967) was used for analysis. The morphometric relationships were denoted by the equation: $Y = a + bx$, where “y” is the dependent variable, “x” is the independent variable and “b” is the regression coefficient. Correlation coefficient (r) value was calculated (Table 7) to know the degree of linear association or interdependence of two variables. The value of “a” is determined by the following formula;

$a = y - bx$, value of “b” is determined by:

$$b = \frac{[n\sum xy - \sum x \sum y]}{[n\sum x^2 - (\sum x)^2]}$$

$$r = \frac{[n\sum xy - \sum x \sum y]}{[\sum x^2 - (\sum x)^2] [\sum y^2 - (\sum y)^2]}$$

Results

Classification

Class: Actinopteri

Order: Mulliformes

Family: Mullidae

Genus: *Upeneus*

Upeneus vittatus (Forsskal, 1775)

Diagnosis

The analysis was carried out on 10 specimens. The size ranged from 126.5-232.3 mm in total length and 23.31-135.8g in total weight. Body is elongated, laterally compressed, dorsal side slightly convex. Mouth is superior, placed sub-terminally, large, rounded, highly protractile and with large mouth gap. Unequal jaws with cardiform teeth, also present on palatine and vomer. Chin with two barbels. Operculum with flap and large opercular opening. Complete and curved lateral line. Ctenoid, rhomboidal, large and overlapping scales present. Two separate dorsal fins; positioned at the middle of the body, which starts from the mid of pectoral fin and reaches up to the just opposite to terminal of anal fin, with spines in front. Pectoral fin large, wide spread and positioned ventro-laterally. Ventral fin medium size and present at the forward. Anal fin with spines in front and reaches up to the opposite of 2nd dorsal fin. Caudal fin forked and homocercal type. This fish was diagnosed by dorsal fin (VIII, 8-9), pectoral fin rays (14-16), ventral fin (I, 5), anal fin (I, 7), Caudal fin (13), lateral line scales (36-38) and total number of gill rakers (27-29) and number of lateral body stripes 4 (Table 8). Color of lateral body stripes- golden reddish. Based on the counts from the present study, the fin formula for *U. vittatus* could be written as $P_{14-16} V_{1,5} D_{VIII,8-9} C_{13} A_{1,7}$.

Coloration

Usually, in fish identification, the color doesn't consider as a character, but instead it is very helpful along with the elaborate descriptions and keys of the fish. *U. vittatus* shows silver ventrally and reddish dorsally. The presence of four stripes which are golden reddish in colour, 2 mid lateral is visible among them, from eye one starts and till base of caudal fin it extends, the adjacent bar attaches to the upper caudal fin lobe. The other stripe starts from beneath the pectoral fin base and spreads up to caudal peduncle and it is merged by lower caudal fin lobe present in adjacent bar; 2 of the dorsolateral stripes, a well-defined lower one, which starts from operculum and extends up to behind the second dorsal fin. The upper stripe is much shorter and ambiguous, it starts from beneath the first dorsal fin origin.

Description

In percentage of Head length (Table 4); 55.00 ±0.49 HW, 79.81 ±0.61 HD, 30.48 ±0.48 ED, 31.77 ±0.60 IOS, 34.96 ±0.54 SnL, 43.78 ±0.59 POL, 42.66 ±0.40 LJL, 38.79 ±0.57 UJL. In percentage of Standard Length (Table 3); 111.0±0.86 FL, 28.7±1.00HL,28.7±0.94

BD, 28.3±0.99 PPL, 22.6±0.94 PFL, 6.0±0.92 PBL, 31.2±0.95 PVL, 19.3±0.77 VFL, 4.7±0.55 VBL, Pre dorsal length 36.9±0.98 PDL, Dorsal fin length 23.7±0.99 DFL, 16.8±0.88 DBL1, 12.8±0.64 DBL2, 67.3±0.62 PAL, 16.5±0.79AFL, 10.0±0.36 ABL, 22.2±0.93 CPL, 11.3±0.74 CPD, 28.5±0.95 CFL.

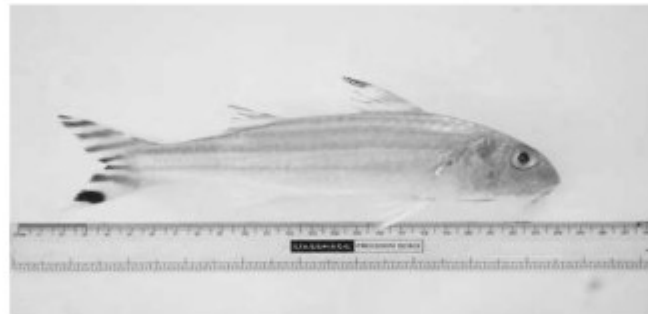


Fig. 2: *Upeneusvittatus*



Fig. 3: Caudal fin and anal fin;(a) Blue = Caudal Fin (b)

Red= Anal fin



Fig. 4: Pectoral fin, Pelvic Fin, Dorsal Fin and Barbel;Yellow= Dorsal Fin (b) White=Pectoral Fin (c) Blue=Pelvic Fin (d) Purple = Barbel

By calculating range, mean, median, standard deviation and coefficient of correlation of morphometric characters; it was found that maximum value of coefficient of variation for PVL (16.20%) while minimum value for POL (14.60%) (Table 5). The r value of total length against other morphometric characters ranged between 0.938 to 0.993. Total length showed maximum degree of correlation with PPL (0.993); while minimum with PFL

(0.938). Likewise, coefficient of correlation of equated morphometric characters ranged from minimum of 0.991 for IOL to maximum of 0.996 for POL against head length (Table 7). Analysis of meristic characters of 10 specimens shown (Table 6) highest coefficient of variation for upper gill rakers (5.95%), dorsal fin rays (5.83%), Pectoral fin rays (4.19%), lower gill raker (3.40%) and lateral line scale (2.1%). While other meristic characters did not show any variation (Table 6).

Table 3: Morphometric characters %in SL (Mean± standard deviation)

| Morphometric | % in SL ± Standard deviation |
|------------------------|------------------------------|
| Fork length | 111.0±0.86 |
| Body depth | 28.7±0.94 |
| Head length | 28.7±1.00 |
| Pre pectoral length | 28.3±0.99 |
| Pectoral fin length | 22.6±0.94 |
| Pectoral base length | 6.0±0.92 |
| Pre pelvic fin length | 31.2±0.95 |
| Ventral fin length | 19.3±0.77 |
| Ventral base length | 4.7±0.55 |
| Pre dorsal length | 36.9±0.98 |
| Dorsal fin length | 23.7±0.99 |
| Dorsal base length 1 | 16.8±0.88 |
| Dorsal base length 2 | 12.8±0.64 |
| Pre anal length | 67.3±0.62 |
| Anal fin length | 16.5±0.79 |
| Anal fin base | 10.0±0.36 |
| Caudal peduncle length | 22.2±0.93 |
| Caudal peduncle depth | 11.3±0.74 |
| Caudal fin length | 28.5±0.95 |

Table 4: Morphometric % in Head length (Mean± standard deviation)

| Morphometric | % in HL ± Standard Deviation |
|----------------------|------------------------------|
| Head width | 55.00 ±0.49 |
| Head depth | 79.81 ±0.61 |
| Eye diameter | 30.48 ±0.48 |
| Inter-orbital Length | 31.77 ±0.60 |
| Snout Length | 34.96 ±0.54 |
| Post orbital | 43.78 ±0.59 |
| Lower Jaw length | 42.66 ±0.40 |
| Upper Jaw length | 38.79 ±0.57 |

Table 5: Statistical estimates of different morphometric characters

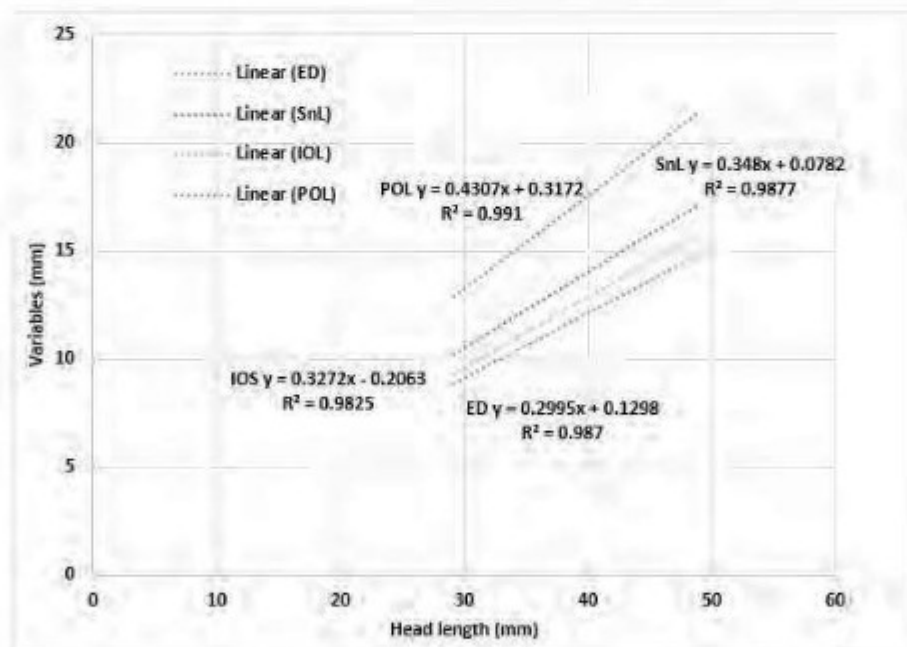
| Morphometric Character | Max (mm) | Min(mm) | Mean | Median | Standard Deviation | Coefficient of variation (%) |
|------------------------|----------|---------|--------|--------|--------------------|------------------------------|
| TL | 232.30 | 126.50 | 190.92 | 202.15 | 30.11 | 15.77 |
| SL | 176.20 | 100.60 | 148.52 | 156.95 | 22.30 | 15.02 |
| PDL | 66.30 | 36.80 | 54.46 | 56.40 | 8.62 | 15.83 |
| PPL | 50.10 | 27.50 | 42.60 | 45.20 | 6.73 | 15.80 |
| PVL | 56.60 | 29.30 | 46.70 | 49.15 | 7.56 | 16.20 |
| PAL | 118.20 | 68.10 | 100.11 | 105.95 | 14.96 | 14.94 |
| HL | 48.90 | 29.20 | 42.50 | 44.90 | 6.28 | 14.79 |
| PFL | 41.60 | 23.40 | 33.69 | 34.90 | 5.31 | 15.77 |
| CFL | 49.30 | 29.90 | 42.52 | 45.05 | 6.28 | 14.77 |
| BD | 49.00 | 29.10 | 42.42 | 45.05 | 6.21 | 14.63 |
| SnL | 17.20 | 10.20 | 14.87 | 15.90 | 2.20 | 14.80 |
| ED | 14.80 | 8.80 | 12.86 | 13.60 | 1.89 | 14.73 |
| IOL | 16.10 | 9.40 | 13.70 | 14.55 | 2.07 | 15.14 |
| POL | 21.70 | 12.90 | 18.62 | 19.70 | 2.72 | 14.60 |

Table 6: Statistical estimates of meristic characters

| Meristic Characters | Max | Min | Mean | Median | Mode | Standard Deviation | Coefficient of variation (%) |
|------------------------------|-----|-----|-------|--------|-------|--------------------|------------------------------|
| Dorsal fin spine | 8 | 8 | 8.00 | 8.00 | 8.00 | 0.00 | 0.00 |
| Dorsal fin rays | 9 | 8 | 8.40 | 8.00 | 8.00 | 0.49 | 5.83 |
| Anal fin spine | 1 | 1 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 |
| Anal soft rays | 7 | 7 | 7.00 | 7.00 | 7.00 | 0.00 | 0.00 |
| Caudal fin rays | 13 | 13 | 13.00 | 13.00 | 13.00 | 0.00 | 0.00 |
| Pectoral fin rays | 16 | 14 | 15.30 | 15.00 | 15.00 | 0.64 | 4.19 |
| Pelvic fin spine | 1 | 1 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 |
| Pelvic fin rays | 5 | 5 | 5.00 | 5.00 | 5.00 | 0.00 | 0.00 |
| Lateral line Scale | 38 | 36 | 37.50 | 38.00 | 38 | 0.80 | 2.1 |
| Scale row above lateral line | 2 | 2 | 2.00 | 2.00 | 2.00 | 0.00 | 0.00 |
| Scale row below lateral line | 6 | 6 | 6.00 | 6.00 | 6.00 | 0.00 | 0.00 |
| Gill raker upper | 8 | 7 | 7.70 | 8.00 | 8.00 | 0.46 | 5.95 |
| Gill raker lower | 21 | 19 | 19.40 | 19.00 | 19.00 | 0.66 | 3.40 |

Table 7: Relationship between different morphometric characters

| Morphometric | Intercept (a) | Slope (b) | Y=a + bx | Correlation (r) |
|--------------|---------------|-----------|------------------------|-----------------|
| TL & SL | 10.651 | 0.7221 | $y = 0.7221x + 10.651$ | 0.975 |
| TL & PDL | 1.3474 | 0.2782 | $y = 0.2782x + 1.3474$ | 0.972 |
| TL & PPL | 0.2027 | 0.2221 | $y = 0.2221x + 0.2027$ | 0.993 |
| TL & PVL | 0.235 | 0.2434 | $y = 0.2434x + 0.235$ | 0.969 |
| TL & PAL | 6.8757 | 0.4883 | $y = 0.4883x + 6.8757$ | 0.983 |
| TL & HL | 3.3015 | 0.2053 | $y = 0.2053x + 3.3015$ | 0.984 |
| TL & PFL | 2.1086 | 0.1654 | $y = 0.1654x + 2.1086$ | 0.938 |
| TL & CFL | 3.7671 | 0.203 | $y = 0.203x + 3.7671$ | 0.974 |
| TL & BD | 3.5475 | 0.2036 | $y = 0.2036x + 3.5475$ | 0.988 |
| HL & SnL | 0.0782 | 0.348 | $y = 0.348x + 0.0782$ | 0.994 |
| HL & ED | 0.1298 | 0.2995 | $y = 0.2995x + 0.1298$ | 0.993 |
| HL & IOL | -0.2063 | 0.3272 | $y = 0.3272x - 0.2063$ | 0.991 |
| HL & POL | 0.3172 | 0.4307 | $y = 0.4307x + 0.3172$ | 0.996 |

**Fig. 5. Relationship of morphometric characters with head length**

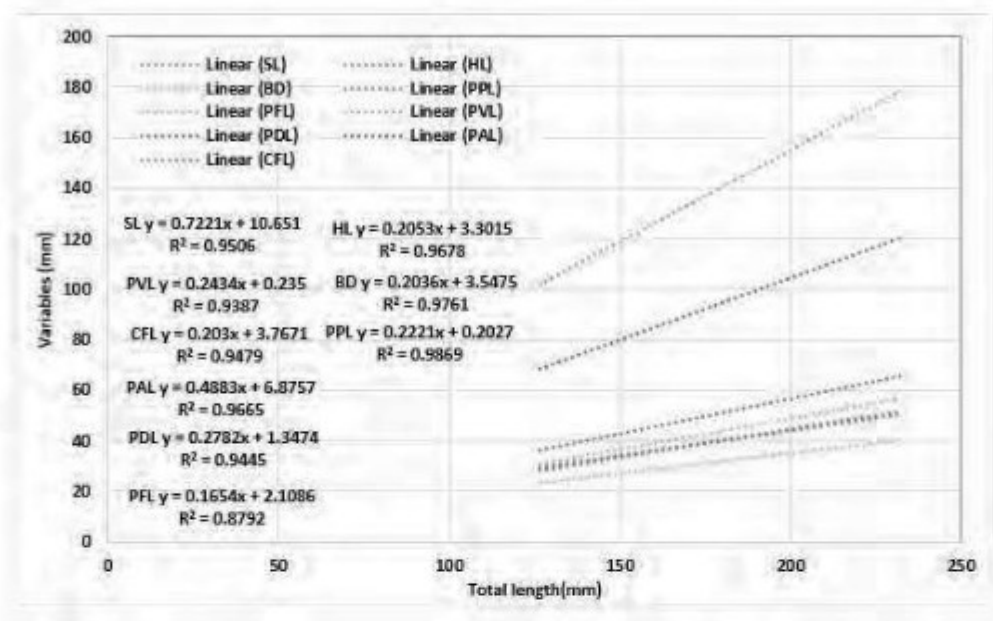


Fig. 6. Relationship of morphometric characters with total length

Discussion

A comparison of the meristic counts of *Upeneus vittatus* in the present study with some earlier works is presented in Table 8 and Table 9. Descriptive meristic characters were found to be in matching with previous descriptions. An analysis of the results obtained in the study indicates that there is negligible variation in the

morphometric and meristic characteristics within the population. Slight variations recorded in the morphometric and meristic characters in the present study when compared to earlier reports may be a result of genetical or environmental factors. Range, mean, median, standard deviation and coefficient of variation of the morphometric characters indicate high degree of homogeneity within the population of *Upeneus vittatus* along the Andaman coast.

Table 8: Comparison of meristic counts of *U.vittatus* with previous literature

| Meristic characters | Present work | FAO, 1983 (a,b,c) | Fischer and Bianchi, 1984 | Uibleinand Heemstra, 2010 | Rajan et al., 2012 | Ramteke et al., 2018 | Saha et al., 2019 |
|---------------------------|--------------|-------------------|---------------------------|---------------------------|--------------------|----------------------|-------------------|
| Dorsal fin spine | 8 | 7-9 | 8 | 8 | 8 | 8 | 8 |
| Dorsal fin rays | 8-9 | 9 | 8 | 9 | 9 | 9 | 8 |
| Ventral fin spine | 1 | 1 | 1 | 1 | - | 1 | 1 |
| Ventral fin rays | 5 | 5 | 5 | 5 | - | 5 | 5 |
| Pectoral fin rays | 14-16 | 13-17 | 15-17 | 15-16 | 15-16 | 15-16 | 14 |
| Anal fin spine | 1 | 1 | 1 | 1 | - | 1 | 1 |
| Anal fin rays | 7 | 6-7 | 7 | 7 | - | 7 | 6 |
| Caudal fin rays | 13 | 13 | - | - | - | - | 13 |
| Lateral line scale | 36-38 | - | 36-38 | 36-38 | 36-38 | - | 37 |
| Scales below lateral line | 6 | - | - | 6 | - | - | 6 |
| Scales above lateral line | 2 | - | - | 2 | - | - | 2 |
| Gill rakers | 27-29 | - | - | 27-29 | 27-29 | - | - |

Table 9: Comparison of *U. vittatus* with *U. tragula*, *U. randalli* and *U. taeniopterus* from previous records of *Upeneus* species

| Meristic Characters | <i>U. Vittatus</i> Present Work | <i>V. tragula</i> (Uibleinand Gouws, 2014) | <i>U. randalli</i> (Uibleinand Gouws, 2014) | <i>U. taeniopterus</i> (Uibleinand Gouws, 2014) |
|--------------------------------|------------------------------------|---|--|--|
| Dorsal Spine | 8 | 8 | 8 | 8 |
| Pectoral Fin | 14-16 | 12-14 | 13-14 | 13-14 |
| No. of lateral body stripes | 4 | 1 | 1 | 2 |
| Lateral line Scale Count | 36-38 | 28-31 | 28-30 | 35-39 |
| No. of gill racker count | 27-29 | 20-25 | 23-25 | 21-23 |
| Colour of lateral body stripes | Golden reddish | Brown to black | Beige | Pale brown |

A detailed continuous study on this species with a greater number of specimens is required. This information can be useful in reducing taxonomical ambiguity of this species as well as planning for fishery management and conservation of this fauna.

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Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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