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Taxonomic study of flatheads (Family: Platycephalidae) occurring along the West coast of India

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A total of thirty-one morphometric and meristic characters were measured, counted and compared among the species along with their respective proportions, like standard length and head length. Among ten meristic characters, six did not show any difference. However, four characters viz. number of gillrakers, black spot on 1st dorsal fin, increasing size of backwardly directed lateral line spines towards posterior end and preopercular spine revealed variations. The proportional measurements with their head length (HL) viz. snout length: head length (SnL: HL, Inter orbital width: head length (IOL: HL), and maximum eye diameter: head length (MED: HL) also revealed significant difference among the species.

[**Keywords:** Grammoplites suppositus, G. scabr, cociella crocodilus, Platycephalidae, morphometric]

Introduction

The Flatheads (Family: Platycephalidae) are distributed in the marine waters of tropical Indo-West Pacific regions[1,2]. The family includes about 17 genera[3] and 70 valid species[4]. There are about 13 species of flatheads, described in Indian waters[5]. Though the flatheads do not form commercial catch, they are landed in significant quantity. Apart from edible value, some of them have important medicinal uses[6]. The flatheads are characterized by an elongated body, dorso-ventrally depressed head and large mouth. Usually the lower jaw is longer than the upper one[7]. These fishes are benthic in nature, frequently found on sandy and muddy bottoms at depths down 10 to 300m, more often in shallower than 100 m[2, 8, 9]. Some taxonomists have made contributions on flatheads in recent past including Matsubara and Ochiai, Weber and De Beaufort, Murty, Kuiter and Immamura and added considerable knowledge onthe taxonomyof the family[3,10-13]. Pored scale on lateral line is a unique morphological character of family Platycephalidae[14]. The differences in the structure of pored scales are useful as generic character in *Platycephalus, Onigocia, Cociella* and *Rogadius*[10]. Other comprehensive morphological features (opening of canals) of pored scales of Platycephalidae were by Hughes[15, 16]. Some species like *G. scaber* (Linnaeus, 1758) and *G. suppositus* (Troschel, 1840) are very similar in external appearance and are difficult to separate from each other. Despite several dedicated efforts in flathead taxonomy, ambiguity still exists in their identification.

Materials and Methods

Fish samples were collected from the trawl landings in Veraval (20.9°N 70.37°E), Porbandar (21°37′48″N 069°36′0″E) (Gujarat), Newferrywharf (18° 57′ 22.97″ N, 072° 50′ 57.34″ E), Sassoondocks (18° 54′ 41.81″ N, 072° 49′ 34.11″ E), Versova (19° 7′ 12″ N, 072° 49′ 12″ E) (Mumbai, Maharashtra) on West coast. Fishes were identified up to species level using available keys and original descriptions.A total of twenty-eight meristic and morphometric characters for three species namely *Grammoplites scaber*, *G. suppositus* and *Cociella corocodilus* were measured in fresh condition. Meristic characters were counted by using a magnoscope and the morphometric characters were measured by using adigital Vernier calipers to the nearest 0.1 mm. The terminology for head spine, as described by Knapp[17] was followed and morphometric traits were measured by following Murty[12].A brief descriptions based on collected specimens of the three species were presented. The descriptive statistics of meristic and morphometric ratios were tabulated for comparison. An analysis of variance (ANOVA) was carried out for morphometric ratios to explore significant difference in mean value across the species. A factor analysis

was carried out for log transformed morphometric variables and variables showing factor loading of more than 0.75 (accounting more to overall variance) were selected for subsequent Stepwise Discriminant Function Analysis (SDFA). A total of eight selected log transformed morphometric ratios were subjected to SDFA. All the statistical analysis was carried out using statistical package (Statistica).

Results and Discussion

Systematics:

Class: Osteichthyes

Subclass: Actinopterygii

Order: Scorpaeniformes

Family: Platycephalidae T. N. Gill 1872

Genus: Grammoplites Fowler 1904

Species: A.*Grammoplites scaber* (Linnaeus, 1758)

B. *Grammoplites suppositus* (Troschel, 1840)

Genus: Cociella Whitley, 1940

Species: C. *Cociella crocodilus* (Cuvier, 1829)

A. *Grammoplites scaber* (Linnaeus, 1758)

It is commonly known as rough flathead. A total of 25 specimens of *G. scaber* (Linnaeus, 1758) were collected from Veraval, Porbandar (Gujarat), and Newferry wharf, Versova(Maharashtra) Munambam (Kerala) fish landing centers West coast of India were examined morphological characters were studied.

Diagnostic characters

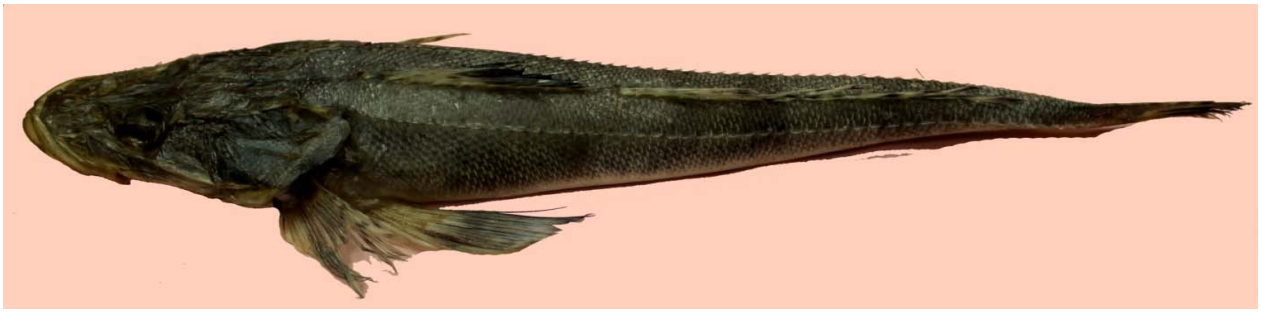
Body elongate, with moderately depressed head, bearing strong spines and bony ridges. Pre-orbital spine present; the suborbital ridge bearing 3 or 4 strong spines. The top of the body brownish and ventral part whitish; first dorsal and caudalfin dusky. Second dorsal fin with a large dark spot on the margin. Body has 5 or 6 cross bands on the body. First dorsal fin base without blotch and all pored lateral line scales bearing a large spine and continue increasing in size towards the distal part of the body.

First dorsal fin with 9spine and 2nddorsal fin with 12 soft rays; anal fin rays 12; pectoral fin rays 19 to 22.The number of gillrakers on the first-gill arch 1 + 6 or 7; preopercular spines 3; the lower 2 smaller, the upper preopercular spine longest and not reaching to margin of the opercular membrane (fig.1b). Lateral line with 52 to 55 pored scales, all bearing large backward directed spine (Fig. 1c) till caudal peduncle. The pored scales of a lateral line have a single opening to the exterior. The number of the scales above the lateral line are equal to the number of pored scales on the lateral line.

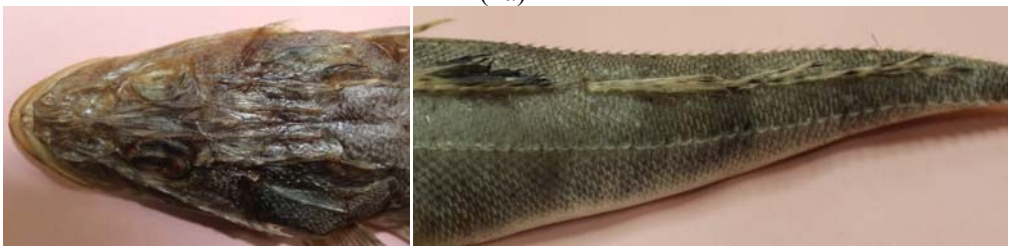
Remarks: Preopercular spine of G. scaber shorter than preopercular spine of *G. suppositus* not reaching upto opercular membrane.

B. *Grammoplites suppositus* (Troschel, 1840)

It is commonly known as rough flathead. A total of 31 specimens of *Grammoplites suppositus* (Troschel,



(1a)



(1b) 1(c)

Fig. 1(a-c)—a) *G. scaber* (Linnaeus, 1758); b) Pre-opercular spine reaching beyond the opercular membrane; c) Spine of pored scale on lateral line reaching beyond the posterior margin

1840) were collected from Veraval, Porbandar (Gujarat), Newferry wharf, Sasoon dock, Versova (Maharashtra) Munambam (Kerala) fish landing centers of India, and the measurement and counts were recorded in fresh condition.

Diagnostic characters

Body elongate with vigorously flattened head. The head bears strong spine and bony ridges. The top part of the body is brownish and ventral part whitish. First dorsal fin has a large black blotch at base (fig. 2a) of the far end and a dark spots on the pectoral, second dorsal and upper lobe of caudal fins.

First dorsal fin with 9 spine, second dorsal fin with 12 soft rays; pectoral fin 21 to 23 rays and anal fin usually 13rays. The number of gillrakers on the first-gill arch 1 + 8; preopercular spines 3; the lower 2 small; the upper preopercular spine long and reaching beyond the margin of the opercular membrane (fig. 2c). Lateral line with 52 to 54 pored scales (fig. 2b), all bearing spine except few on the distal part of the body.

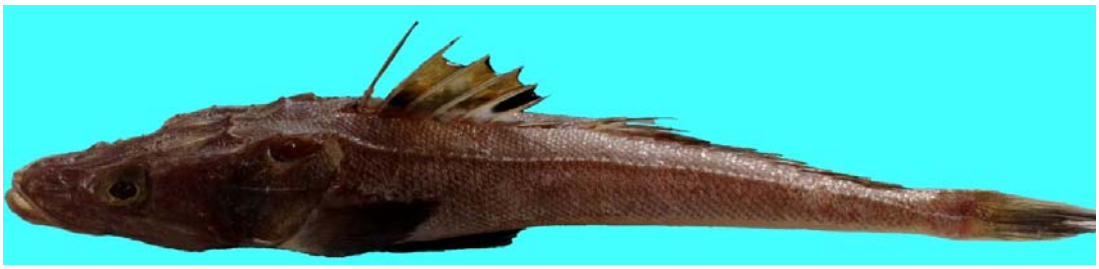
Remarks: The pored lateral line scale of the *G. suppositus* is shorter than the spine on pored lateral line scales of *G. scaber* not reaching beyond the margin.

C. *Cociella crocodilus* (Cuvier, 1829)

It is commonly known as Crocodile flathead. A total of 9 specimens of *Ccciella crocodilus* (Cuvier, 1829) collected from Veraval, Porbandar (Gujarat), Newferry wharf, Sasoon dock, Versova (Maharashtra) fish landing centers of India were examined. The morphometric measurement and meristic counts were recorded in fresh condition.

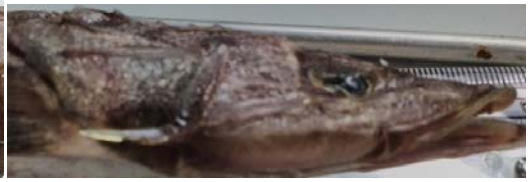
Diagnostic characters

Body elongate with vigorously flattened head. The head bears strong spine and bony ridges.Small doted spotspresent all over the body; with 4 or 5 cross band (fig. 3a);1st dorsal fin dusky. Sub orbital ridge bears 3 spine, 1st spine in front of eye, 2nd at the middle of eye and 3rd at posterior margin of the eye (fig. 3b). The body is dark. The upper caudal rays longer than lower.



(2a)

(2b)



(2c)

Fig. 2(a-c)—a) *G. suppositus* (Troschel, 1840); b) The spine of pored scale on lateral line not reaching beyond the posterior margin; c) Preopercular spine reaching beyond the opercular membrane

(3a)

(3b)

Fig. 3(a-b)—a) *C. crocodiles* (Cuvier, 1829); b) Head part, spines on sub orbital ridge

First dorsal fin with nine spine, second dorsal and anal fins with 11 soft rays; pectoral fin 19 to 22 rays. The number of gillrakers on the first-gill arch 1 +5; Preopercular spines usually 3; the lower 2 smaller than upper one, the upper preopercular spine not reaching the margin of the opercular membrane. Lateral line with 52 to 54 pored scales; anterior 2 to 15 scales bear small spine.

Remarks**:** A small black spot on body no. of anal fin rays 11 while in the case of *G. scaber* and *G. suppositus* anal fin rays 12 and 13 respectively.

Morpho-meristic differentiation

Traditional flathead taxonomy has been dependent on the meristic characters and gross morphological features with varying degree of success. The major meristic features used for species differentiation were either the fin rays count or spines present on different parts. The major morphological features of taxonomic importance are blotch on fins and bands on body[4, 19, 20]. In present study ten meristic characters for the three species of flatheads were compared (Table. 1).

Several characters were found to be consistent within species whereas DSFR and GLRU were also found to be consistent across the three considered species. Most of the meristic characters showed contrasting counts between the two genera namely *Cociella* and *Grammoplites* whereas within genera clear demarcation is not so strong. Barring ANFR, none of the characters alone were able to distinguish among all the three species. ANFR for *C. crocodiles, G. supposites* and *G. scaber* were 11, 13 and 12, respectively that separates the three species, narrowly. The ranges for different meristic characters were found concurrent with description of Troschel, Day, Fisher and Bianchi and Knapp[5, 8, 20, 21].

Table 1—Descriptive statistics of different meristic characters of three species of family Platycephalidae occurring along west coast of India

	G. suppositus (N = 31)		*G. scaber* (N = 25)		*C. crocodiles* (N = 9)	
Variables	Med	CV	Med	CV	Med	CV
SCABLL	52	3.73	53	1.21	66	5.74
DSFS	9	0.00	9	0.00	9	0.00
DSFR	12	0.00	12	0.00	11	0.00
ANFR	13	0.00	12	0.00	11	0.00
PCFR	20	3.75	19	2.46	20	2.50
PLvFR	6	0.00	6	0.00	6	5.46
GLRU	1	0.00	1	0.00	1	0.00
GLRL	8	7.43	6	3.36	5	0.00
LLSC	52	3.88	53	1.29	64	4.08
PLLSC	52	4.54	53	1.29	54	1.54

Note: Med=Median; CV= Coefficient of variation; SCABL= Number of scales below the lateral line; DSFS= Number of spines on the first dorsal fin; DSFR= Number of rays on the s econd dorsal fin; ANFR= Number of rays on the anal fin; PCFR= Number of rays on the pectoral fin; PlvFR= Number of rays on the pelvic fin; GLRU= Gill rakers on the upper limb of first gill arch; GLRL= Gill rakers on the lower limb of first gill arch; LLSC= Number of scales on the lateral line; PLLSC= pored scales with lateral line

Morphometric characters have not been intensively used for species discrimination by the earlier workers. Some workers have incorporated morphometric variables scaled either to standard length or head length but unlike meristic characters, they rarely used them for face to face comparison between species[4, 5]. In present investigation we have compared 8 morphometric variables scaled to standard length and 9 morphometric variables scaled to head length for indicating difference in mean values among the three species. An analysis of variance (ANOVA) carried out for the morphometric ratios showed significant difference in mean except for PAL/SL, POL/HL and MED/HL, where difference in mean were insignificant at 5% level of significance (Table 2). F-Value for length of upper pre-opercular spine (LPrOSU) was significantly higher than other, emphasizing on the considerable difference in mean value across the species. The length of the spine in *G. supposites* was found to be considerably longer than the remaining two species (2-3 times longer). Similar observations were also quoted by George[1] while comparing *Platycephalus scaber* (G. scaber) and *Platycephalus maculipinna* (*G. supposites*). Anal fin length (ABL/SL) showed marked difference among the three species and could find application in species separation either alone or in combination with other variables. Pre-orbital length (PrOL/HL) in G. scaber was found to be substantially shorter than the rest of the two species. Pre-orbital length along with head length (HL) and different spine lengths were among the key morphometric variables catalogued by the Day[5] and Murty and Manikyam[4] while describing species of family Platycephalidae. Taxonomic importance of these variables was also realized during current investigation.

Eight sorted morphometric ratios after factor analysis were subjected to Stepwise Discriminant Function Analysis (SDFA) to explore more relevant morphometric featuresand for their classification or discrimination power. The SDFA incorporated six out eight fed variables in the model.

Table 2—Descriptive statistics of different morphometric variables of three species of family Platycephalidae occurring along west coast of India

Species	*C. crocodiles* (N=9)		*G. suppositus* (N=31)		*G. scaber* (N=25)	
Variables	Mean	CV	Mean	CV	Mean	CV
HL/SL*	0.356	3.69	0.362	9.92	0.316	7.35
PDL/SL*	0.369	2.32	0.355	10.34	0.315	6.88
PPvL/SL*	0.393	2.80	0.382	9.50	0.345	6.87
PAL/SL	0.612	2.35	0.581	13.68	0.553	2.83
PPL/SL*	0.300	3.08	0.299	9.39	0.268	7.03
DBL1/SL*	0.200	2.65	0.219	17.50	0.176	10.93
DBL2/SL*	0.267	2.74	0.313	9.47	0.328	4.65
ABL/SL*	0.287	3.75	0.354	12.28	0.327	8.88
DBwULJ/HL*	0.042	10.81	0.047	7.73	0.040	14.22
LPrOSU/HL*	0.060	13.09	0.217	10.74	0.083	12.61
LPrOSL/HL*	0.026	25.18	0.050	27.62	0.053	11.82
PrOL/HL*	0.320	1.08	0.314	4.61	0.277	10.55
POL/HL	0.504	2.36	0.521	2.37	0.515	5.79
SnL/HL*	0.305	2.59	0.297	6.23	0.261	12.94
MED/HL	0.179	4.50	0.184	11.85	0.168	23.70
MLSDS/HL*	0.421	7.29	0.091	20.86	0.067	22.34
MLSDR/HL*	0.359	7.39	0.376	12.61	0.348	8.97

Note: *Significant difference in mean at 5% level of significance, SL: Standard length, HL: Head length, SnL: Snout length, MED: Maximum eye diameter, POL: Post orbital head length, PDL: Pre dorsal length, DBL 1: First dorsal fin base, DBL 2: Second dorsal fin base length, ABL: Length of anal finbase; MLSDR: Maximum Length of 2nd dorsal ray, PPL: Pre Pectoral length, PPvL: Pre-pelvic Length, PrOL: Pre-orbital length, IOW: Inter orbital width, MLFDS: Maximum Length of first dorsal spine, MLSDS: Maximum Length of 2nd dorsal spine, PAL: Pre anal fin length, AFBL: Anal fin base length, DBwULJ: Diff. between U and L jaw, LPrOSU: Length of preopercular spine upper, LPrOSL: Length of preopercular spine lower

The relative importance of these incorporated variables in the model is expressed by their loading on functions (Roots). Highest factor loadings of ABL/SL on both the Roots stresses upon its higher discriminating power compared to other variables. Rest of the incorporated variables showed more or less equal contribution in species discrimination (Table: 3).

SDFA has generated a classification matrix showing a correct classification in 98.46% cases with only one instance of misclassification (Table. 4). One case of G. supposites is predicted as G. scaber by the model. An instance of misclassification between *G. supposites* and *G. scaber* indicated toward the morphometric proximity of these species which is further affirmed by the lower squared Mahalanobis distance (22.136) between the two species.

Table 3—Factor structure matrix for the three species

Variables	Root 1	Root 2
PrOL/HL	-0.27842	-0.26408
DBL2/SL	0.273168	-0.20242
PDL/SL	-0.24058	-0.17656
HL/SL	-0.20208	-0.30325
ABL/SL	0.062476	-0.42777
PPvL/SL	-0.21112	-0.16095

Table 4—Classification matrix generated by SDFA model for three species of family Platycephalidae from west coast of India

Species	%	*G. scaber*	*G. suppositus*	*C. crocodilus*
G. scaber	100	25	0	0
G. suppositus	96.77	1	30	0
C. crocodilus	100	0	0	9
Total	98.46	26	30	9

Table 5—Squared Mahalanobis distance between three species of family Platycephalidae from west coast of India

Species	*G. scaber*	*G. suppositus*	*C. crocodilus*
G. scaber	0.000	22.316	77.956
G. suppositus	22.316	0.000	35.519
C. crocodilus	77.956	35.519	0.000

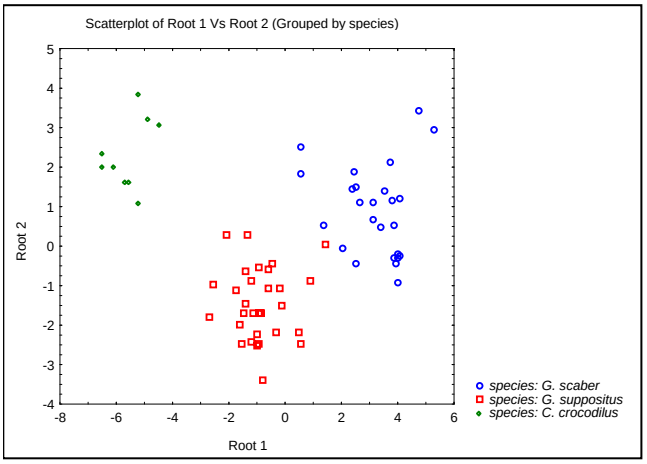


Fig. 4—Scatter plots of canonical scores for Root 1 and Root 2 of the morphometric variables of three species of Platycephalidae occurring along the west coast of India

C. crocodilus was found to be most distant to *G. scaber* in morphometric terms as the value of squared Mahalanobis was recorded maximum for the pair (Table. 5).

The sufficiency of the considered variables in species discrimination and predictive or classification power of the model is reflected by the scatterplot of canonical scores where different cases of the same species were grouped together and well separated from the clusters of the other species (Fig. 4). Several of the variables included in the model like head length, pre-orbital length, Pre-dorsal length and length

of fin bases has also featured in past literatures, highlighting their realized importance[1, 4, 5,18].

Conclusions

The importance of meristic characters in species differentiation of members of family Platycephalidae had not been successfully used in India in past. The taxonomic ambiguity related to the family Platycephalidae has been resolved in the present study. The study also established the possible applicability of morphometric variables in species differentiation of these fishes which were otherwise less explored in previous works.

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