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Stock identification of *Priacanthus hamrur* (Forsskal, 1775) (Order: Perciformes and Family: Priacanthidae) from Indian waters based on morphometric, meristic and otolith traits

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In this study, stock discrimination of *P. hamrur* has been done from the Indian coast based on morphometric traits, meristic counts and otolith shape. During the study period, 370 specimens were collected from the Indian coast. A total of 14 morphometric traits, 10 meristic counts and 6 sagittal otolith shape parameters were studied for discrimination purpose. Discriminate function analysis was used to separate the stocks from different locations using Statistica (12) software. Meristic counts were the same in all the four stocks and have no role in stock separation. Differentiation of stocks was observed based on morphometric and otolith analysis. Analysis of morphometric characters showed little mixing between Mumbai and Cochin stocks. Squared Mahalanobis distance analysis showed Kakinada and Kolkata were closest stock whereas Mumbai and Kakinada were least similar stock. Among the three methods, incremental distance analysis of otolith has been found to be most suitable for separation of stock. The present study will provide basic of stock assessment and help in the susutainable management of this resource.

[**Keywords**: Discrimination, Meristic, Morphometric, Otolith, Statistica, Stock]

Introduction

Bull's eye (*Priacanthus hamrur*) has emerged as one of the potential fishery resources in the trawl catch along the west and east coasts of India. The depth of operation of trawlers was 10-80 m along the east coast and 20-150 m off the west coast. Priacanthids are reported from 40-100 m depth range in S-W coast and 100-200 m depth range along the N-W coast. Bull's eye was recorded in the depth of 50-400 m along the Kerala and Karnataka coast with maximum occurrence in 100 to 150 m depth[1]. This deep sea fishmigrates towards coastal water during pre-monsoon for the spawning purpose[2]. Landing petterns of the bull's eye has significantly changed during the year 2016. Landings of bull's eye have been escalated six times high of 1.30 lakh t in 2016 as compared to 2015[(ref. 3)]. Demersal finfish formed 29 % of total catch in which *Nemipterus* spp., *Sciaenids* and *Priacanthus* spp. were found as dominant groups. The estimated total landings of *Priacanthus* spp. during the year 2016 were 29068 t which contributed 2.6 % of the total marine landings of Kerala. The major species in the commercial fishery were *Priacanthus hamrur* (86 %), *Cookeolus japonicus* (12 %), *Priacanthus sagittarius* and *Heteropriacanthus cruentatus* (1 % each) (CMFRI Annual Report 2016-17)[3]. Stock identification of species is essential for sustainable fisheries management because most of the analytical tools assume that the fishes has homogeneous vital rates (e.g., growth, maturity, mortality) in a particular stock. Stock delineation is a basic and important step in fisheries management that involves the identification of self-sustaining components within its natural populations[4,5]. Therefore, the present study has been conducted to identify stocks of *P. hamrur* using meristics, traditional morphology and otolith shape analysis which give a good insight into the stock relationships of this species.

Materials and Methods

During the study, specimens of *P. hamrur* were collected from the landing centres of Versova (Maharashtra) & Cochin (Kerala) on the west coast and Kakinada (Andhra Pradesh) & Digha (West Bengal) in the east coast during October 2017 to January 2018. Eleven meristic counts were taken into account for the current study (Table 1). The meristic characters were counted following the widely used and reliable method[6]. Morphometric data was also extracted based on the traditional method (Table 2). Sagittal otolith has been extracted from the fish and washed in 70 % ethanol and photographs taken under stereozoom microscope (Olympus). There is no such difference found among the right and left sagittal otolith (Fig. 1). Incremental distance analysis of otolith was done by using Image-Pro Premier 9.1, 64 bit (Media Cybernetics). Factor analysis was performed for all the morphometric, meristic and otolith data separately. Among all the characters loaded above the threshold value (0.6) were selected for forward stepwise discriminant analysis by using Statistica (12) software[6].

Results

The factor loadings after varimax rotation for the meristic variables, morphometric variables and otolith variables were analyzed. The characters having factor loading of above 0.60 on any of the first two factors were selected for subsequent Stepwise Discriminant Analysis. The scatter diagrams of meristic variables (Fig. 2) are not able to separate the stock, whereas morphometric (Fig. 3) and otolith variables (Fig. 4) showed discrimination among different stock.

Table 1 — Meristic counts of *P. hamrur*

Sl. No.	Meristic counts	Acronyms
1	Dorsal fin spines	DFS
2	Dorsal fin soft rays	DFR
3	Pectoral fin rays	PFR
4	Pelvic fin spines	PEFS
5	Pelvic fin rays	PEFR
6	Anal fin spines	AFS
7	Anal fin rays	AFR
8	Caudal fin rays	CFR
9	Total gillrakers on the first gill arch	GR
10	Branchiostegal rays	BGR
11	Scales on the lateral line	SAL

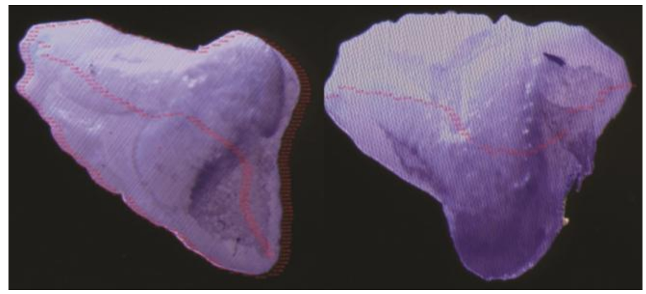

Fig. 1 — Incremental distance analysis of Sagittal Otolith

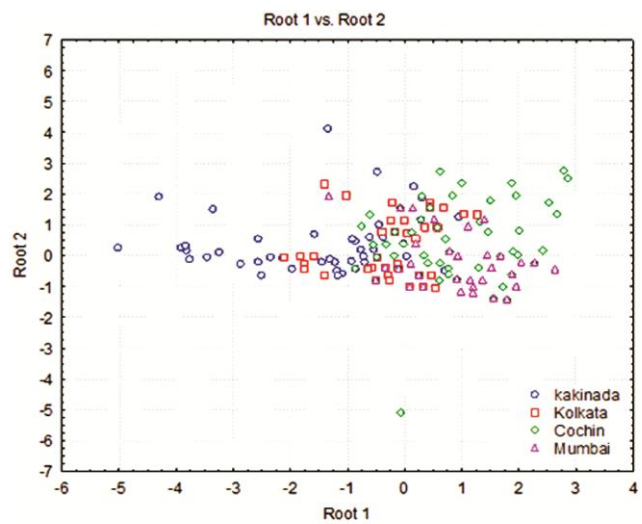

Fig. 2 — Scatter plot of meristic variables

Table 2 — Morphometric traits of *P. hamrur*

Sl. No.	Morphometric traits	Acronyms	Description
1	Standard length	SL	Straight length from the tip of the snout to the base of the caudal fin rays.
2	Head length	HL	Straight length from the tip of the snout to the posterior margin of the operculum
3	Eye diameter	ED	The diameter of the eye along the body axis
4	Pre dorsal length	PrDL	Distance from the tip of the snout to the origin of the dorsal fin
5	Post dorsal length	PoDL	Distance from the tip of the snout to the end of the dorsal fin
6	Dorsal fin base length	DFBL	Distance between the origin and end of the dorsal fin
7	Pre pelvic fin length	PrPL	Distance from the tip of the snout to origin of the pelvic fin
8	Post pelvic fin length	PoPL	Distance from the tip of the snout to end of the pelvic fin
9	Pelvic fin base length	PFBL	Distance between the origin and end of the pelvic fin
10	Pre anal fin length	PrAL	Distance from the tip of the snout to origin of the anal fin
11	Post anal fin length	PoAL	Distance from the tip of the snout to end of the anal fin
12	Anal fin base length	AFBL	Distance between the origin and end of the dorsal fin
13	Depth of insertion of the anal and dorsal fin	DPC	Distance between insertion of the dorsal fin and the insertion of the anal fin.
14	Distance between dorsal-fin origin and anal fin origin	DPrDL PrAL	Distance between dorsal-fin origin and anal fin origin

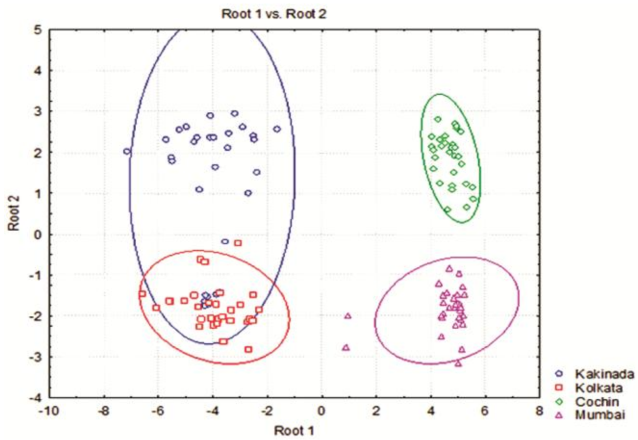

Fig. 3 — Scatter diagram of morphometric variables

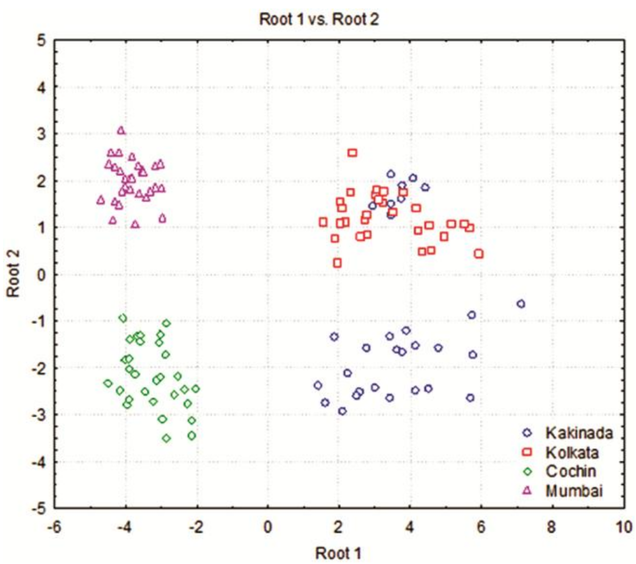

Fig. 4 — Scatter diagram of otolith variables

Squared Mahalanobis distances analysis

Based on the morphometric (Table 3) and otolith (Table 4) characters Squared Mahalanobis distances revealed significant differences among the stocks with maximum distance between Mumbai and Kakinada followed by Kolkata and Cochin while the minimum distance was observed between Kolkata and Kakinada followed by Mumbai and Cochin.

Discussion

Meristic characters

Meristic traits are the countable characters in fish body. Different authors have reported meristic characters of *P. hamrur* such as spines on the dorsal fins (10), dorsal fin rays (13-14), spines on the anal fins (3), anal fin rays (14-15), pectoral fin rays (17-20), lateral-line scales (70-90) and total gillrakers (22-26)[7,8]. Hence, it is clear that the overall meristic traits found in our study are almost similar to the previously reported studies. In the present study, variations in meristic characters were less compared to morphometric characters. The variations between stocks were attributed to the gillrakers and the lateral line scales numbers. The variations in gillrakers of fishes and scale count due to isolation caused by differences in salinity gradients were also reported[9,10]. In this current study, it was found that the number of gillrakers varied in the range of 20-25 (Table 5). Gillrakers count and inter-raker spacing variation within species is greater in the warm water fish species[11,12]. Size of the prey at each location plays an important role in the inter-raker spacing variations in fishes[13]. Physiochemical variables like water temperature, turbidity and salinity may also affect

Table 3 — Squared Mahalanobis distance between different stocks based on morphometric characters

Site	Squared Mahalanobis Distances			
	Kakinada	Cochin	Kolkata	Mumbai
Kakinada	0.00000	8.34937	2.64222	**30.97721**
Cochin	8.34937	0.00000	27.58596	7.44004
Kolkata	**2.64222**	27.58596	0.00000	16.87737
Mumbai	30.97721	7.44004	16.87737	0.00000

Table 4 — Squared Mahalanobis distance between different stocks based on otolith

Group	Kakinada	Kolkata	Cochin	Mumbai
Kakinada	0.00000	9.86984	51.95831	**64.70004**
Kolkata	**9.86984**	0.00000	55.58416	55.30522
Cochin	51.95831	55.58416	0.00000	19.01581
Mumbai	64.70004	55.30522	19.01581	0.00000

Table 5 — Fin formula of *P. hamrur* as reported by the present study

Fin formula	D, X+12-15; A, III+11-15; P, 14-18; V, I+4-5; GR, 20-25

D = Dorsal fin, A = Anal fin, P = Pelvic fin, V = Ventral fin, GR = Gill rakers gillrakers morphology[14,15]. Local environmental conditions influence the meristic characters and as a result increase their variation at small geographic scales[16]. Hence, the variation in gill rakers observed in the present study might be the result of variations in ecological factors. As water temperature decreases, the number of vertebrae, fin ray and scale counts tend to increase in number (Jordan's rule)[17]. Meristic counts are the easiest methods of stock identification compared to other methods and relatively easier to implement, which makes them as the basic steps of stock discrimination[18]. Meristic counts can be useful in the separation of populations in early life stages from small geographical area, which may be utilized for the recognition of spawning components[19]. Thus, meristic traits when compared with morphometric variables, showed significantly lower variation among the four stocks of *P. hamrur* collected from the Indian coast.

Morphometric characters

Change in the morphological characters of the fish population occurs by the ecological and evolutionary process. Polymorphism involves diversification in behavior, morphology or life history traits in populations and is most commonly seen in vertebrate populations[20-22]. Morphometric traits of fish are susceptible to environmental changes thus exhibit high plasticity of phenotypic or external characters in overall body shape where phenotypic plasticity indicates the expression of genotypic changes to an alternative environmental condition producing an array of phenotype[23].

Incremental distance analysis of Otolith

Otolith shape analysis can be used to identify fish stocks from different geographical locations, similar to other morphological methods. However, otolith shapes are more reliable due to its less chance of short-term variability, unlike other body shapes. Change in body structure is caused by the changes in feeding habit or breeding condition[24]. Furthermore, otolith shape also can be interrelated with individual growth rate[25]. For example, the difference in otolith shape is used to know the growth rate of Atlantic mackerel and indicates the morphological changes in the fish body[26]. Six parameters of otolith shape were used in the discrimination of four stocks. Discriminant function analysis was applied for the separation of stock based on otolith morphometric traits. Similar types of incremental distance analysis from flathead fish was also reported[27]. The earlier investigators did not do this type of analysis for *P. hamrur*.

The analysis of meristic counts, morphometric traits and otolith shape asserted the separation of four stocks along the Indian coast. The results revealed a clear separation of Mumbaiand Cochin stocks whereas little mixing was observed in Kakinada and Kolkata stocks. Distinguishable variation in morphology among fish populations suggests the presence of a stock structure, and the movement of the stock is restricted[28]. The Morphological variability of fish due to segregation is considered to be an essential adaptive strategy for populations experiencing inconsistent environments[29,30]. The Arabian Sea and Bay of Bengal ecosystems are distinct ecosystems in terms of both physical and chemical parameters as reported by various authors[31]. Several methods such as meristic counts, morphological characters, otolith shape, scale morphology, fatty acid profile and molecular tools can be used to discriminate stocks from different locations. In the present study, three methods were incorporated (meristic counts analysis, morphological variation and otolith shape analysis) to delineate the stock. Out of these three methods meristic count does not give a clear picture for separation of stocks. At the same time, morphological characters and otolith shape played a significant role to separate the stock of *Pricanthus hamrur* from Indian waters[32]. To know the further clear separation of *P. hamrur* stock the stock genetic studies may be done[33].

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Conflict of interest

Authors do not have any conflict of interest.

Author contributions

First author has collected sample and extracted data, and others authors have contributed in data processing, analysis and writing of manuscript.

References

1 Joseph K M, Salient observations on the results of fishery resources survey during 1983-84, *Bull Fish Surv India*, 13 (1984) 1-2.

2 Vijayakumaran K & Naik S K, A study of the stock of *Priacanthus hamrur* (Forskal) during March and September between lat. 11 degree-16 degree N along the west coast of India, Studies on the fish stock assessment in Indian waters, *Special publication, Fish Surv India*, 2 (1989) 106-119.

3 Anon, *Annual Report*, (Central Marine Fisheries Research Institute, Cochin), 2016-17, pp. 186.

4 Crandall K A, Bininda-Emonds O R P, Mace G M & Wayne R K, Considering evolutionary processes in conservation biology, *Trends Ecol Evol*, 15 (7) (2000) 290-295.

5 Thorpe J, Gall G, Lennan J, Nash C & Cross N J C, Conservation of Fish and Shellfish Resources, Managing Diversity, *Zool J Linn Soc*, 117 (2) (1996) 205-211.

6 Hubbs C L, Lagler K F & Smith G R, Fishes of the Great Lakes region (revised), *Cranbrook Inst Sci Bull*, 26 (1958) 1-213.

7 Koteswaramma R, On an advanced postlarva of *Priacanthus hamrur* (Forsk.) (Pisces: Priacanthidae) from the Krishna Estuary, *Mahasagar*, 15 (1) (1982) 55-57.

8 Stearns S C, The influence of size and phylogeny on patterns of covariation among life-history traits in the mammals, *Oikos*, 1983, 173-187.

9 Ikusemiju K, A comparative racial study of catfish, *Chysichthysni grodigitatus* (Lacepede) from Lagos and Lekki lagoons, Nigeria, *Bull I F A N 37 Ser A*, 4 (1975) 887-898.

10 Omoniyi T & Agbon A O, Morphometric Variations in *Sarotherodon melanotheron* (Pisces: Cichlidae) from Brackish and Fresh Water Habitats in South-western Nigeria, *West African J App Eco*, 12 (2007) 89-95.

11 Moodie G E, Gill raker variation and the feeding niche of some temperate and tropical freshwater fishes, *Environ Biol Fish*, 13 (2004) 71-76.

12 Amundsen P A, Knudsen R, Klemetsen A & Kristoffersen R, Resource competition and interactive segregation between sympatric whitefish morphs, *Finnish Zool & Bot Pub Board*, (2004) 301-307.

13 Matsumoto K & Kohda M, Differences in gill raker morphology between two local populations of a benthophagous filter-feeding fish, *Goniistius zonatus* (Cheilodactylidae), *Ichth Res*, 48 (3) (2001) 269-273.

14 Lindsey C C, Stocks are chameleons: plasticity in gill rakers of coregonid fishes, *Canadian J Fish Aqua Sci*, 38 (1981) 1497-1506.

15 Loy A, Corti M & Cataudella S, Variation in gillraker number during growth of the sea bass, *Dicentrarchus labrax* (Perciformes: Moronidae), reared at different salinities, *Env Bio Fish*, 55 (1999) 391-398.

16 Turan C, Stock identification of Mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters, *ICES J Mar Sci*, 61 (2004) 774-781.

17 McDowall R M, Jordan's and other ecogeographical rules, and the vertebral number in fishes, *J Biogeo*, 35 (3) (2008) 501-508.

18 Heincke D F, Natural history of herrings, *German treatises fish club*, 2 (1898) 128-233.

19 Swain D P, Hutchings J A & Foote C J, Environmental and genetic influences on stock identification characters, In: *Stock identification methods*, 2005, pp. 45-85.

20 Robinson B W & Wilson D S, Character release and displacement in fishes: a neglected literature, *Am Nat*, 144 (1994) 596-627.

21 Wimberger P H, Trophic polymorphisms, plasticity, and speciation in vertebrates, In: *Theory and application in fish feeding ecology*, edited by D J Stouder, K L Fresh & R J Feller, (Wiley), 1994, pp. 19-43.

22 Smith T B & Skúlason S, Evolutionary significance of resource polymorphisms in fishes, amphibians, and birds, *Anl Rev Eco Sys*, 27 (1) (1996) 111-133.

23 Thompson J D, Phenotypic plasticity as a component of evolutionary change, *Trends Eco Evol*, 6 (8) (1991) 246-249.

24 Lohmann G P & Schweitzer P N, Oneigenshape analysis. In: *Proceedings of the Michigan Morphometrics Workshop*, edited by F J Rohlf & F L Bookstein, (Univ Michigan Museum of Zool Spec Publ, 2), 1990, pp. 147-166.

25 Campana S E & Casselman J M, Stock discrimination using otolith shape analysis, *Canadian J Fish Aq Sci*, 50 (5) (1993) 1062-1083.

26 Castonguay M, Simard P & Gagnon P, Usefulness of Fourier analysis of otolith shape for Atlantic mackerel (*Scomberscombrus*) stock discrimination, *Canadian J Fish Aq Sci*, 48 (2) (1991) 296-302.

27 Vikas, Taxonomic evaluation of family Platycephalidae from Indian waters, M. F. Sc, Dissertation, Central Institute of Fisheries Education, Mumbai, India, 2016.

28 Elliott N G, Haskard K & Koslow J A, Morphometric analysis of orange roughy (*Hoplostethus atlanticus*) off the continental slope of southern Australia, *J F Bio*, 46 (2) (1995) 202-220.

29 Stearns S C, The effects of size and phylogeny on patterns of covariation in the life history traits of lizards and snakes, *Am Nat*, 123 (1) (1984) 56-72.

30 Wimberger P H, Plasticity of jaw and skull morphology in the neotropical cichlids *Geophagus brasiliensis* and *G. steindachneri*, *Evol*, 45 (7) (1991) 1545-1563.

31 Sherman K & Duda A M, An ecosystem approach to global assessment and management of coastal waters, *Mar Eco Pro Series*, 1999, pp. 271-287.

32 Cadrin S X, Karr L A & Mariani S, Stock identification methods: an overview, In: *Stock Identification Methods*, 2nd edn, 2014, pp. 1-5.

33 Vidya R, Gopalakrishnan A, Biradar R S, Jahageerdara S, Asokan P K & Kizhakudan J K, Mitochondrial DNA marker reveals shallow genetic structuring in *Priacanthus hamrur* (Forsskål, 1775) along the Indian coast, *J Mar Bio Assoc India*, 59 (2) (2017) 29-35.