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Fishery, reproductive biology and diet characteristics of Bombay duck *Harpadon nehereus* from the Saurashtra coast

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Fishery, reproductive biology and diet characteristics of Bombay duck *Harpadon nehereus* landed by dol netters along the Saurashtra coast was studied during 2006 – 2009. Annual average catch was 25,479 t with catch rate of 378.6 kg unit^{-1} forming 22.44% of the total dol net catches. Bulk of the catch was landed during September – January and in May. Length weight relation differed significantly between males, females and indeterminates. Growth was isometric in males but allometric in females and indeterminates. Overall sex ratio was 1.05 and length at first maturity was 214.5 mm. Gravid and ripe females were observed throughout the year with peak occurrence during April – June. Mature ovaries contained immature (0.2 - 0.39 mm), maturing (0.5 - 0.69 mm) and mature ova (0.8 - 0.89 mm). Total fecundity was between 8467 and 102079. Non penaeid prawns viz., *Acetes* and *Nematopalaemon tenuipes* was the most important food item in the diet followed by sciaenids, unicorn cod and juveniles of Bombay duck. Fishes with empty stomachs were encountered in high numbers. Juveniles fed mostly on non penaeid prawns while adults preferred both finfishes and prawns. Feeding intensity was more in adults and less in juveniles. The reproductive biology and food and feeding were found to vary significantly between years.

[**Keywords:-** Bombay duck, Fishery, Spawning, Food and feeding, Dol nets, Saurashtra]

Introduction

Bombay duck (*Harpadon nehereus* Ham.) forms one of the most important commercial fishery along the Saurashtra coast of India wherein it accounted for 24% and 13% of the total catch during 1980-1984 [1] and 2002-2006 [2]. Bombay duck resource along the Saurashtra coast is heavily concentrated and highly localized with bulk of the fishery from within a narrow belt of 45 km at depth range of 20 – 70 m and the important landing centres are Nawabunder, Rajpara and Jaffrabad. Bombay duck shares a unique ecosystem with gold spotted anchovy and non penaeid prawns in that it oscillates with the tidal amplitude. Fishing season for Bombay duck commences in September and continues up to January when the fish is available in nearshore waters. The fish migrates to deeper waters and becomes scattered during February to May and hence are available in smaller numbers.

The Bombay duck resource along the Saurashtra coast is of an independent stock [3,4]. The discontinuous distribution of Bombay duck has been attributed to various factors, the principal ones being the distribution and movements of the favourite food organisms, the variations in salinity and the fluctuations in the surface temperature of sea water [3]. Species is primarily caught with the bag-net, better known as "dol" net of 35 – 60 m length and with a codend mesh of 20 mm. The operation of this gear is timed to a strong tidal current at depths ranging from 20 – 30 m. Codend mesh size and the depth of operation are seasonally changed to take maximum possible advantage of the bathymetric range of Bombay duck. The nets are hauled depending on the turn of the tide. Bag with the mouth set against the current strains the fish which is being retained therein by the strength of the current and the net is then retrieved. Bombay duck is a soft fish and is highly perishable due to its body composition. A large part of the catch particularly during the peak fishing season is sundried on raised bamboo platforms by hanging them on ropes and the dried fish is exported.

Bombay duck is a continuous spawner with prolonged breeding season and exhibits cannibalistic feeding behaviour [3,5,6]. The reproductive biology and diet characteristics of this species from the Saurashtra waters was studied few decades back [3,6]. Increasing mechanization in the operation of dol nets in recent years has resulted in the vertical and horizontal

extension of the fishing area for dol nets which can have an impact on the reproduction and diet of Bombay duck. Present study therefore attempts to reassess the reproductive biology and food and feeding of this resource based on detailed data collected from the dol net catches of all the three centres along the Saurashtra coast.

Materials and Methods

Data on catch and effort expended for *Harpadon nehereus* were collected weekly from the dol net landing centres of Nawabunder, Rajpara and Jaffrabad for the four year study period from January 2006 to December 2009, except from middle of June to middle of August for all the years when the dol net fishery was suspended due to monsoon. The monthly and annual estimates of catches were made following the procedure adopted by the Fishery Resource Assessment Division of Central Marine Fisheries Research Institute, India [7]. A total of 1733 specimens from Nawabunder, Rajpara and Jaffrabad were collected and total length (cm) and body weight (grams to 0.01 g precision) were measured. The length - weight relationship was calculated as $W = aL^b$ [8] separately for both sexes and indeterminates and significant differences in the slopes of the regression lines for males, females and indeterminates were ascertained by ANACOVA [9]. The monthwise sex ratio was determined from 1671 specimens and Chi-square test was performed to test the homogeneity of male and female distribution. The size at first maturity (L_{50}) was determined from 857 female specimens logistically by fitting the fraction of mature fish (stage III and above) against length interval using the nonlinear least square regression method [10]. Proportions of gravid and ripe females (V and VI) over time were taken to determine the spawning season. The gonadosomatic index (IG) for females was calculated by the formulae: IG = (*Weight of gonad* × 100) / *Weight of fish*. Fecundity was worked out by raising the number of ova in all subsamples of the mature and ripe ovary (V and VI) to the total ovary weight. The ovary subsamples were obtained from the anterior, middle and the posterior regions of the ovary. The ova diameter distribution in each subsample of the ovary was studied under a microscope using calibrated ocular micrometer. The feeding intensity from 1701 specimens was assessed based on the distension of their stomach and the volume of food contained in it and was classified as full, ½ or more full, ¼ full and empty. The relative importance of various food items in the food filled stomachs was calculated by the index of relative importance [11]. The index of relative importance (IRI) was used as it takes into account the frequency of occurrence as well as the number and volume of each food item thus providing a definite and measurable basis for grading different food items. The IRI was computed as given below:

$IRI = (\%N + \%V) \times \%F$; where N = number, V = volume and F = frequency of occurrence.

Multivariate analyses on diet contents were carried out using PRIMER v. 6 [12]. Prior to the statistical analyses, datasets were square-root transformed, and similarity matrices were constructed using the Bray-Curtis similarity coefficient. The monthly IRI were used to identify the annual and seasonal variation in their dietary composition. For this purpose, one-way Analysis of Similarity Percentages (SIMPER) was performed to test similarity/dissimilarity in the diet contents between months and years. When seeking similarities between years/months, hierarchical cluster analysis was applied to the food composition/frequency data in order to distinguish groups of samples of similar dietary composition. The SIMPROF permutation procedure was used to test the significance of the clusters.

Results

Fishery

Average annual catch of *H. nehereus* at Nawabunder, Rajpara and Jaffrabad for the period 2006 – 2009 was 25,479 t contributing 22.44% to the total dol net catches. Average catch rate was 378.6 kg unit^{-1}. The annual catch exhibited a decrease over the years from 30247 t in 2006 to 19776 t in 2009. Catch rate similarly decreased from 407.9 kg unit^{-1} in 2006 to 327.6 kg unit^{-1} in 2009. Contribution of *H. nehereus* to total fish catch by dol nets was maximum in 2008 with 25.1 % and minimum in 2009 with 20.3 %. Analysis on seasonal abundance of *H. nehereus* revealed peak landings during September - January. Average total landing in these months was 19,225 t with a monthly mean of 3,845 t. Secondary peak in landing was observed in May wherein on an average 2,846 t was landed. Catch rates were also higher during September – January and May with an average of 461.3 kg unit^{-1} and 331.6 kg unit^{-1}, respectively. The contribution of *H. nehereus* to the dol net catches was similarly higher in the months from September to January (26.8%) and May (25.7%).

Length composition

The length frequency distribution for the four year period indicated exploitation of juveniles in large numbers (30 mm – 59 mm) during January of 2006, June of 2007 and January, May and September of 2008. Lowest annual mean length of 196.0±38.8 mm was recorded in 2007. Annual mean length in other years remained more or less the same (211.6±24.5 – 215.9±27.2 mm) (ANOVA, F = 0.79, $P>0.05$). The highest mean lengths were recorded in the months from August – January and in May and the lowest mean length was recorded in June (Fig. 1) (ANOVA, F = 1.66, $P>0.05$). Length weight relationships estimated were:

Male: $\log W = -2.2721 + 3.0111 \log L$ (r = 0.90) (Confidence Level 95%)

Female: $\log W = -1.3657 + 2.3574 \log L$ (r = 0.82) (Confidence Level 95%)

Indeterminate: $\log W = -3.0448 + 3.6015 \log L$ (r = 0.96) (Confidence Level 95%)

Regression line slope for females differed significantly from males (ANACOVA, F_{cal} = 59.64, $P<0.05$) and the regression line slope for males (ANACOVA, F_{cal} = 12.72, $P<0.05$) and females (ANACOVA, F_{cal} = 27.23, $P<0.05$) differed significantly from indeterminates. Slope (b) of the regression relation for females (Student's t test, t_{cal} = 10.91, $t_{crit\ 0.05}$ = 1.96) and indeterminates (Student's t test, t_{cal} = 3.54, $t_{crit\ 0.05}$ = 2) varied significantly from 3 indicating allometric growth. For males however, the slope (Student's t test, t_{cal} = 0.21, $t_{crit\ 0.05}$ = 1.96) did not vary significantly from the isometric value of 3.

Sex Ratio and Size at first maturity

Females dominated ($P>0.05$) the commercial catches in all the years with an overall sex ratio of 1.05. The chi-square values indicated significant ($P<0.05$) dominance by females in October and November and by males in February (Table 1). *H. nehereus* attained sexual maturity at 214.5 mm total length (Fig. 2). However, gonadal development and sexual maturity in the species was observed to commence from 145 mm onwards.

Spawning season

Gravid and ripe females were recorded in all the months with their peak occurrence observed during April – June (Fig. 3). Proportion of mature females were found to vary significantly (ANOVA, F = 6.38, $P<0.05$) between years with their highest occurrence of 67.6±27.0% observed in 2007 and their lowest occurrence of 12.8±12.1% observed in 2009. Gonadosomatic index also varied significantly within years (ANOVA, F = 6.71, $P<0.05$). Highest gonadosomatic index of 2.40±1.14 was recorded in 2007 and the lowest of 0.57±0.32 was recorded in 2009. Gonadosomatic index for females varied in different months with the highest values observed during May - June (average 2.28±1.28) (Fig. 3). This

Table 1—Monthly occurrence of males and females in the landings Saurashtra coast during 2006 – 2009

Months	Male	Female	F/M	Chi squa
Jan	81	70	0.86	0.80
Feb	96	66	0.69	5.56
Mar	131	102	0.78	3.61
Apr	96	100	1.04	0.08
May	71	84	1.18	1.09
June	11	12	1.09	0.04
Aug	68	67	0.99	0.01
Sept	71	70	0.99	0.01
Oct	65	92	1.42	4.64
Nov	67	120	1.79	15.02
Dec	57	74	1.30	2.21

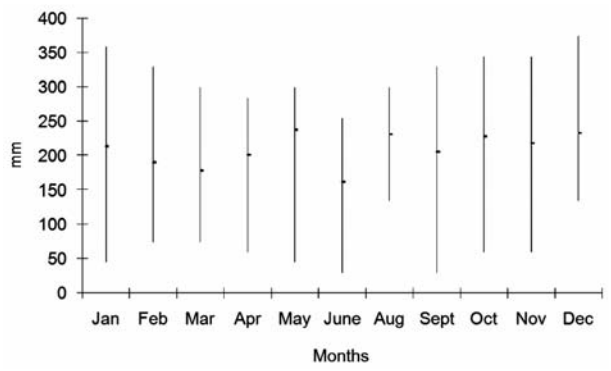

Fig. 1—Length range and mean length of *Harpadon nehereus* in different months in dolnets along Saurashtra coast during 2006 – 2009

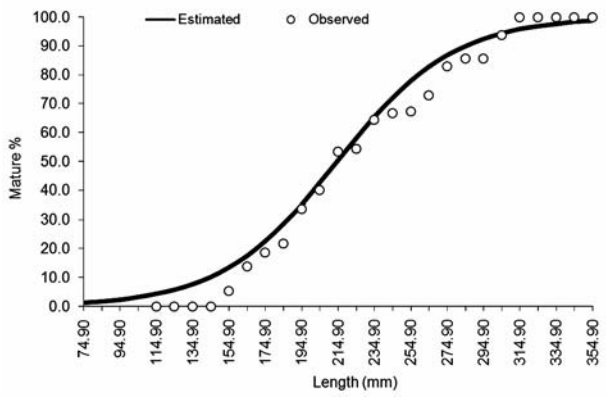

Fig. 2—Size at first maturity of females of *H. nehereus* from Saurashtra coast

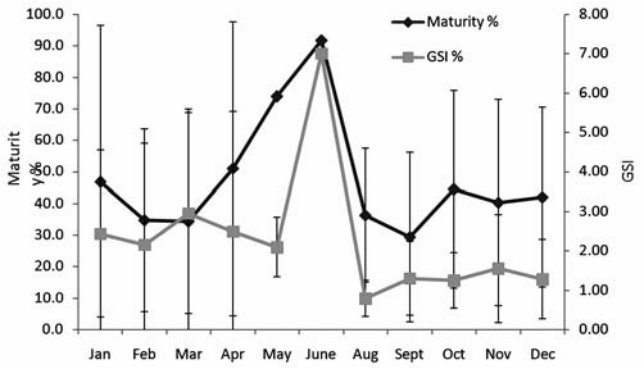

Fig. 3—Maturity % (Mean±SD) and gonadosomatic index (Mean±SD) of females of *H. nehereus* during different months along Saurashtra coast

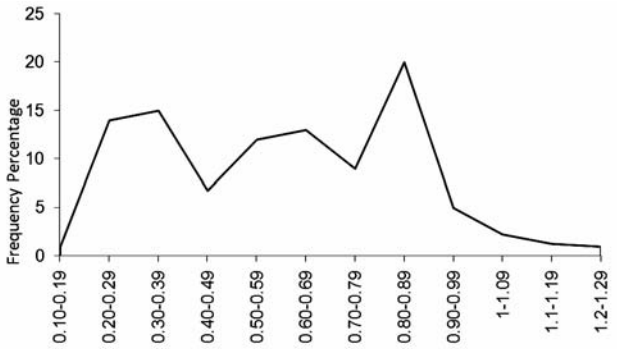

Fig. 4—Ova diameter distribution percentage in mature and ripe ovaries of *H. nehereus*

is in general agreement with the peak spawning season observed in the species. Mature ovaries of *H. nehereus* contained immature, maturing and mature ova. Modal peak in mature ova diameter was 0.8 to 0.89 mm, maturing ova diameter was 0.5 to 0.69 mm and of immature ova diameter was 0.2 to 0.39 mm (Fig. 4). Presence of yolked ova of different sizes in mature ovary for all months of the year indicated continuous spawning. However the largest sizes of yolked ova were encountered mostly in May - June further confirming this to be the peak breeding season of *H. nehereus*.

Fecundity

The number of eggs released increased with the weight and size of fish. Average number of ova per gram body weight was 388.3 with individual values ranging from 94.8 to 1080.6. Relative fecundity varied significantly (ANOVA, F = 4.31, $P<0.05$) within years with the highest value of 589.8±223.0 recorded in 2006 and the lowest value of 282.3±200.1 recorded in 2008. Total fecundity ranged between 8467 and 102079. The relationship calculated between body length and fecundity and body weight and fecundity was:

$\log F = 1.1850 + 2.3536 \log L$ (r = 0.99) (Confidence Level 95%)

$\log F = 3.0116 + 0.7784 \log W$ (r = 0.99) (Confidence Level 95%)

Feeding intensity and food composition

The food items in the diet of *H. nehereus* were broadly classified into fin fishes dominated by unicorn cod, sciaenids, gold spotted anchovy and juveniles of Bombay duck and shell fishes dominated by non penaeid prawns and penaeid prawns. Non penaeid prawns was the most important food item and were dominated by *Acetes* and *Nematopalaemon tenuipes* with average IRI % of 30.0 and 21.9, respectively. *Acetes* were most abundant in gut during 2006 and 2008 with IRI % of 42.7 and 50.3. *Nematopalaemon tenuipes* dominated the gut contents in 2007 and 2009 with IRI % of 27.2 and 39.1. Non penaeid prawns were encountered in the gut contents in all the months and in all the years. Highest index for *Acetes* was observed from February – May (40.0% - 60.7%) and in November (43.3%) and for *Nematopalaemon tenuipes* was observed in January (39.1%) and December (49.1%). A linear association (Pearson Correlation Coefficient: 0.5; $P<0.1$) was observed between landings of Bombay duck and the IRI % of non penaeid prawns in their diet contents. Among fin fishes, sciaenids with an average IRI % of 12.9, unicorn cod with an average IRI % of 10.2, juveniles of Bombay duck with an average IRI % of 9.6 and gold spotted anchovy with an average IRI % of 2.1 were the important food items. Sciaenids represented mostly by juveniles of *Johnius dussumieri* and *Otolithes cuvieri* dominated the gut contents in 2007 with IRI % of 18.2 while the unicorn cod *Bregmaceros mcclellandi* were present in the gut in substantial quantities in all the years with highest IRI % of 22.7 recorded in 2009. Juveniles of Bombay duck were encountered in high numbers in the gut contents in 2007 with an IRI % of 16.4 while the gold spotted anchovy *Coilia dussumieri* were mostly found in 2008 and 2009 with an average IRI % of 3.6. Sciaenids was a major food item of *H. nehereus* in June and August (average IRI % of 52.2), unicorn cod dominated the gut contents in January (IRI % of 20.2) and March - April (average IRI % of 26.0), juveniles of Bombay duck formed an important component of diet in September (IRI % of 43.1) and gold spotted

anchovy dominated in January (IRI % of 12.1). Fin fishes and shell fishes in digested and semi digested state were encountered in the gut in varying proportions in different years in all the months with an average IRI % of 5.9. Penaeid prawns composed chiefly of *Solenocera* spp. and *Parapenaeopsis stylifera* were also observed in the gut contents with average IRI % of 2.3 and 1.5, respectively. Occurrence of *Solenocera* spp. in the gut was mostly in 2006 with IRI % of 10.2. *Solenocera* spp. was mostly abundant in September with IRI % of 14.7 while *Parapenaeopsis stylifera* dominated the gut contents in May with IRI % of 13.8.

Cluster analysis from average SIMPER similarity/dissimilarity in the diet contents revealed significant monthly (SIMPROF, pi = 3.42, P=0.006) and annual (SIMPROF, pi = 2.12, P=0.063) differences (Figs 5 and 6). Analysis of food items in relation to body size depicted that while juveniles fed mostly on non penaeid prawns, adults preferred

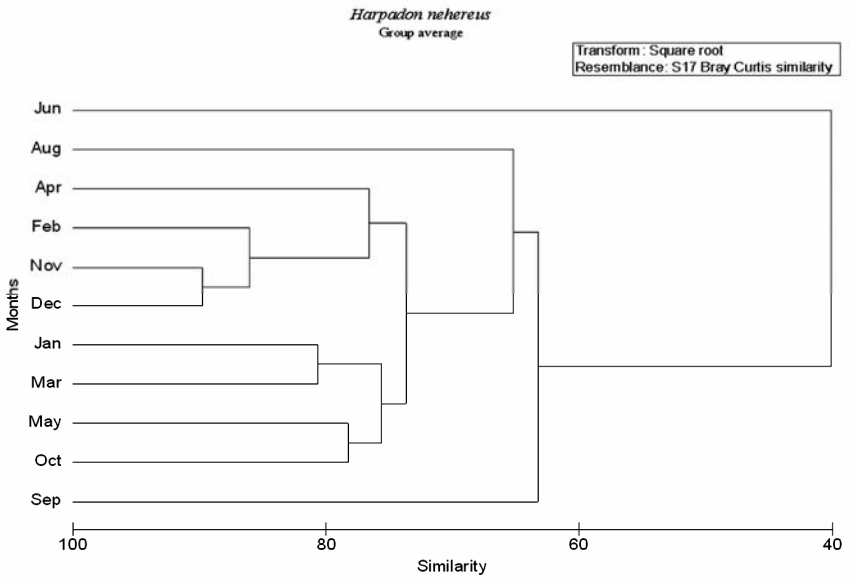

Fig. 5—Dendrogram for clustering food items by IRI for comparing months in Saurashtra coast using group average linking of Bray-Curtis similarities

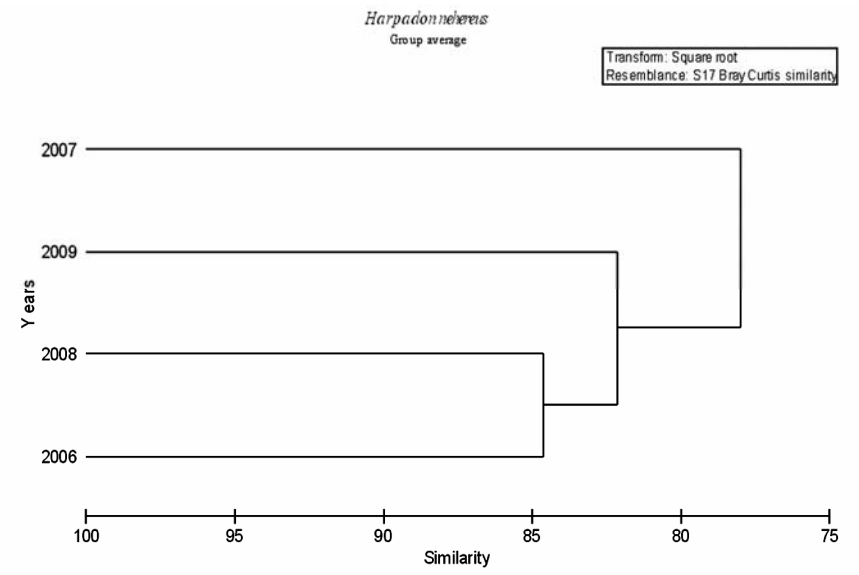

Fig. 6—Dendrogram for clustering food items by IRI for comparing years in Saurashtra coast using group average linking of Bray-Curtis similarities

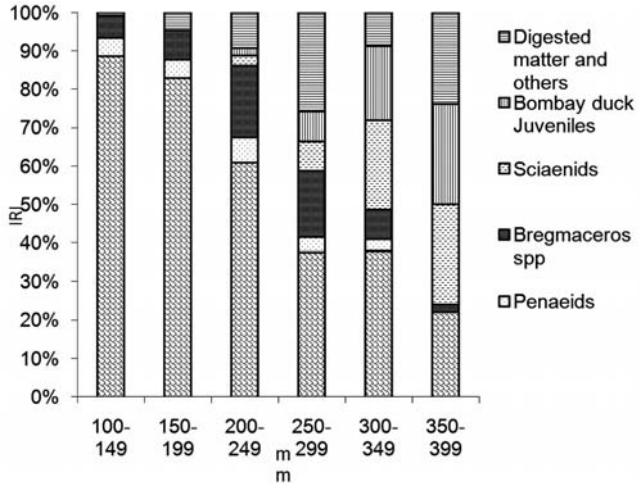

Fig. 7—Size-wise feeding preference of *H. nehereus* along Saurashtra coast

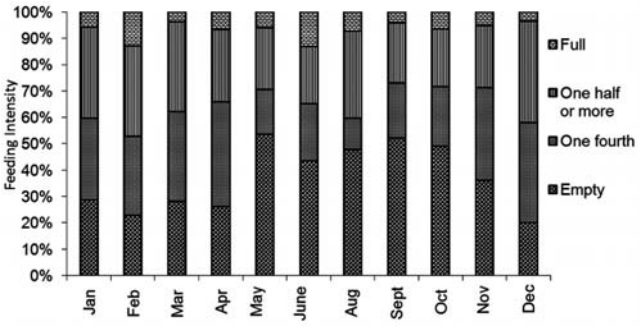

Fig. 8—Month-wise feeding intensity of *H. nehereus* along Saurashtra coast

finfishes and prawns. Size wise feeding preferences is given in Fig. 7. Average contribution of fishes in the feeding conditions of full stomach, ½ or more full stomach, ¼ full stomach and empty stomach were 6.9%, 28.7%, 27.4% and 37.0%. The feeding intensity varied in different years. In 2007, around half of the fishes exhibited empty stomachs while 13.6% had their stomachs full. Proportion of fishes with empty stomachs was 36% in 2006 and 2008 with more than 30% of them having their stomachs one half or more filled in both the years. One fifth of the fishes possessed empty stomachs in 2009 with nearly half of them having stomachs one fourth filled and 35% of them having stomachs one half or more filled. Intensity of feeding was found to vary throughout the year with fishes possessing empty stomachs encountered frequently in all the months (20.0% - 53.6%) (Fig. 8). Empty stomachs were found to be positively correlated with the catches of Bombay duck (Pearson Correlation Coefficient: 0.6; $P<0.05$). The sizewise feeding intensity is depicted in Fig. 9.

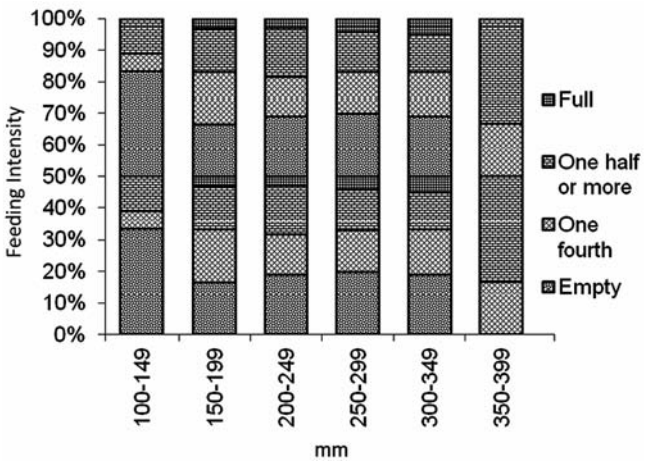

Fig. 9—Size-wise feeding intensity of *H. nehereus* along Saurashtra coast

Sizewise feeding differences revealed that young ones of *H. nehereus* fed less abundantly than that of adults.

Discussion

The catch and catch rates of *H. nehereus* in dol nets has declined over the years along the Saurashtra coast. Highest catch and catch rate recorded in 2006 coincided with the improvement in the operational efficiency of dol nets. Winches driven by 87-105 HP engines were used to shoot and haul dol nets from 2005 – 2006 onwards and stone heaps used earlier for anchoring were replaced by portable and dismantable iron/steel long pipes/pillars. This enabled towing of an additional dol net with the same effort and manpower and bumper catches could easily be hauled on board. Additionally, the modification in anchoring caused less damage to the nets and enabled the fishermen to change their fishing grounds frequently providing flexibity in their fishing operations. Moreover during 2005 – 2006, the fishermen at Nawabunder, Rajpara and Jaffrabad started venturing out from the overexploited 20 – 30 m depth to the unexploited 40 – 70 m depth for setting their dol nets [13]. However as fishing intensified in the 40 – 70 m depth during 2007 – 2009, the catch and catch rate gradually decreased. Annual average landing along the Saurashtra coast during 1984 – 1989 was 32,645 t [6] and during 1979 – 1982 was 39,679 t [14], which is higher when compared to the present landing. Bombay duck formed 68.6% – 77% of the dol net catches at Nawabunder during 1976 – 1978 [15] and 90.6% of the dol net landings at Jaffrabad during 1979 – 1982 [14]. However in the present study, the average contribution of *H. nehereus* to the dol net

landings was only 22.4%. The huge landings of non penaeid prawns, especially *Acetes* sp. in dol nets in the recent past is the cause for this decreased contribution. Though the landing of Bombay duck has decreased from 2006 onwards, the catches of non penaeid prawns have peaked and now account for 70% of the dol net landings. The highest landing of Bombay duck in 2006 coincided with the lowest landing of non penaeid prawns. Moreover, the removal of large quantum of predatory fishes by fishing in recent years could have also created favourable conditions for the non-penaeid prawns to proliferate. This fishing down the food web could have a detrimental effect on the ecology of the Saurashtra coast.

The primary peak of abundance in catch and catch rate during September – January and secondary peak in May are in full agreement to those reported by earlier workers for Bombay duck landed from Nawabunder, Rajpara and Jaffrabad [6,13,14,16]. Fishery of Bombay duck begins by September along the west coast of India and remains in full swing till the end of January. This is the static phase for the fish wherein it becomes temporary resident in the nearshore areas. Dynamic phase begins by February, wherein the big fishes move away from the inshore waters and reappear in big shoals by next September – October [5,17]. Seasonal abundance of *H. nehereus* correlated well with the higher mean lengths observed during August – January and May. Along the Saurashtra coast, protection is provided to the fishery during June – August when fishing is suspended for the monsoon, which could also have contributed to the usually high catch and catch rates and higher mean lengths in the post-monsoon season.

Mean lengths observed were higher than 110 – 120 mm reported during 1976 – 1979 [16] and 151.6 – 199.2 mm reported during 2003 – 2006 [13] from the Saurashtra waters. This increase in mean size is probably because of the increase in the depth of operation of the dol netters in recent times at Nawabunder, Rajpara and Jaffrabad. Growth was isometric in males and allometric in females and indeterminates. Length weight relation varied significantly within the sexes and between adults and indeterminates. This variation is due to biological phenomenon viz., rapid weight increment of ovary in advanced maturity stages of females and differences in the intensity of feeding and food habits of adults and indeterminates. This is in sharp contrary to the findings of earlier workers [13,14] who stated no significant difference in the slopes of the regression relation between males and females.

Females dominated the commercial catches of *H. nehereus* in all years. The domination by females was significant in October and November and by males in February. This could be attributed to the differential fishing because of the changes in the pattern of migration of sexes to and from the fishing grounds [13]. Similar preponderance of females in the catch with varying sex ratios in different months was observed in earlier studies from Mumbai waters [3] and Saurashtra waters [13]. Length at first maturity observed conforms to 200 – 230 mm reported from Mumbai [3,5,18] but is less than 232.5 – 266 mm reported from Saurashtra [6,19]. Differences in exploitation rates and patterns, food availability and environmental parameters are the reason for this observed variation. Gonadal development and sexual maturity were found to commence much earlier in the present study because fish tend to mature early when the fishing pressure is high. The occurrence of gravid and ripe females in all the months with a peak in April – June indicated continuous spawning with peak in the summer period. Similarly along the Mumbai coast, the peak spawning was from April – July [5,18]. However in an earlier study from Saurashtra waters, peak spawning activity was recorded during December – January and June [6]. Higher gonadosomatic indexes and larger sizes of yolked ova during April – June further conforms this to be the peak breeding period. The significant variations in annual productivity caused by monsoon could possibly explain the differences observed in proportion of mature females and gonadosomatic index over the years [20]. The presence of one batch of mature ova, one batch of maturing ova and one batch of immature ova in a mature ovary suggest that individual fish spawns continuously in a year. This disapproves the earlier observations where individuals of Bombay duck were found to spawn only once in a year [3,6]. Possible reason for this deviation could be the fact that in earlier studies the occurrence of gravid and ripe females in the commercial catches was few as dol netters were operated in nearshore waters which were away from the breeding grounds. However with technologic advancement, dol netters are operated in deeper waters in recent years enabling collection of a large number of spawners with fully ripe ova. Similar

fecundity estimates ranging from 14,600 – 1,46,400 were reported from Mumbai [3] and 17,075 – 79,631 were reported from Saurashtra [6] in earlier studies. The increase in fecundity in relation to the weight of fish is much lower than that of the length of fish. Slope of the regression relation between fecundity and body length in the present study was lower than 3.4 obtained in an earlier study from Mumbai [5].

H. nehereus is carnivorous and cannibalistic in nature with trophic level value of 3.7 [21]. Non penaeid prawns dominated by *Acetes* and *Nematopalaemon tenuipes* was their most preferred food item. The tremendous increase in the occurrence of non penaeid prawns in recent years[2] along the Saurashtra coast has resulted in them dominating the gut contents of Bombay duck. Similarly along Mumbai coast, *H. nehereus* were found to feed mostly on *Acetes* and moderately on *Nematopalaemon tenuipes* [22]. The presence of its favored prey viz., *Acetes* and *Nematopalaemon tenuipes* influences the distribution and abundance of Bombay duck [23]. Bombay duck catches were higher when non penaeids were most abundant in their gut. However no perceptible association was observed between feeding intensity and the abundance of non penaeids. Among fin fishes, sciaenids represented mostly by juveniles of *Johnius dussumieri* and *Otolithes cuvieri*, *Bregmaceros mcclellandi*, juveniles of Bombay duck and *Coilia dussumieri* were the important prey items. The presence of juveniles of Bombay duck in the gut indicates its cannibalistic food habits. It is most abundant in gut during September and this happen to be after the peak spawning season wherein juveniles are available in plenty. Bombay duck is often observed with part of prey including adults of sciaenids and *Coilia dussumieri* hanging from the mouth. The wide gape of the mouth and the presence of jaws with fine, innumerable long recurved teeth facilitate in catching hold of such large sized preys. *H. nehereus* showed annual and monthly variations in diet composition and feeding intensity. Diet content in the month of June was significantly different from other months in the year. Sciaenids dominated the gut contents with less of non penaeid prawns. Similarly, the occurrence of juveniles of sciaenids and Bombay duck in considerable amounts in the gut in 2007 at the expense of non penaeid prawns and the unicorn cod accounted for the interannual variations. Fishes possessing empty stomachs were higher during August – October and May which incidentally are the months exhibiting the highest catches. The abundance of Bombay duck in the nearshore waters in these months probably causes depletion in the available food and consequently many of the fishes had empty stomachs. The catch and catch rate of Bombay duck was lowest in February coinciding with the highest percentage of fishes having their stomachs full. It can therefore be concluded that feeding intensity and seasonal abundance are negatively correlated to an extent. Likewise the annual catches of Bombay duck were also found to be strongly associated with the prevalence of empty stomachs. Their response to annual and monthly changes in prey availability reflected the opportunistic behaviour and the trophic adaptability of this carnivore [24]. Juveniles fed mostly on non penaeid prawns while adults preferred both finfishes and prawns. Ontogenetic switches in feeding habits are common in fish and result from increases in body and mouth size that permit fish to capture a broader range of prey sizes and types [25]. The feeding intensity was more in older fishes and less in younger fishes. This is because as fish grows in size and age several morphological changes occur in the form of increase in mouth size and improvement in locomotion ability which enhances their prey catching efficiency.

Conclusion

Females dominated the catches with a prolonged breeding season. Juveniles fed almost entirely on non penaeid prawns while adults preferred both fin fishes and prawns. There has been a decline in the catch and catch rate of *H. nehereus* along the Saurashtra coast because of intensive fishing pressure. Abundance of non penaeid prawns has also surged in recent times. This could adversely impact the ecosystem and its food web. Reducing fishing pressure on *H. nehereus* for their judicious exploitation on a sustainable basis will help to improve the status if this resource. This will slowly aid in replenishing the fishery to a healthy and sustainable level.

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