V. RESULTS

4.1. Food and feeding habits

For this study, a total of 1,126 specimen were examined during September, 2005 - May, 2006, out of which 457 were male and 669 were female. During September, 2006-May, 2007, 1,736 specimen were examined out of which 790 were male and 946 were female.

4.1.1. Qualitative and quantitative analyses

The details of qualitative and quantitative analyses of Priacanthus hamrur during the study period are presented in Table 1A(i) & 1A(ii) & Fig. 1A(i) & 1A(ii) and Table 1B(i) & 1B(ii) & Fig. 1B(i) & 1B(ii).

4.1.1.1. During September, 2005 - May, 2006 period

Analysis of the gut content in both sexes showed that shrimps, semi-digested matter, crustaceans remains and fish juveniles formed the major food items. Teleosts, squid juveniles, cuttlefish juveniles, octopus juveniles and crab juveniles also occurred in considerable quantity.

In male, the gut contents consisted approximately 3.59% teleosts, 11.48% fish juveniles, 2.62% squid juveniles, 1.20% cuttle fish juveniles, 2.29% octopus juveniles, 1.85% crab juveniles, 35.02% shrimps, 15.17% crustacean remains and 26.77% semi-digested matter, while in female, the proportion of gut contents were 5.30% teleosts, 11.48% fish juveniles, 2.65% squid juveniles, 1.54% cuttle fish juveniles, 2.22% octopus juveniles, 2.77% crab juveniles, 40.12% shrimps, 11.37% crustacean remains and 23.07% semi-digested matter.

Shrimps

In male, shrimps (35.02%) were recorded in all the months with peak in September (44.55%) and October (44.44 %) followed by December (37.25 %). The lowest quantity of this item was found during May (28.85%). In case
of female, shrimps (40.12%) were found in greater abundance during September (49.02 %) and October (46.60%) followed by December (45.45%). The lowest quantity was found during May (33.67%). The various genera of shrimps could not be identified due to its autolysis condition but some could be identified and majority of shrimps were found to be *Penaeus* spp.

**Semi-digested matter**

In male, semi-digested matter (26.77%) formed the bulk of the stomach content next to shrimps. The maximum quantity was recorded in the month of November (30.39%) followed by December (28.28%) and April (28.16%). The lowest quantity was recorded in the month of February (22.77%). In case of female, (23.07%) were found in greater abundance during November (25.49%) followed by April (24.75%) and May (24.49%). The lowest quantity was found during September (19.61%). In most cases, the food was in a digested condition, which may be due to the delay in landing of the catch.

**Crustacean remains**

In male, crustacean remains (15.17%) were another important food items next to shrimps and semi-digested matter. They were recorded throughout the study period with peak in the month of April (22.33%) followed by May (18.27%) and January (17.82%), while it was lowest in the month of March (10.78%). The crustacean remains mainly included appendages, shells and other parts of crabs and shrimps.

In case of female, crustacean remains (11.37%) were also recorded in all the months with peak in the month of April (14.85%) and May (14.29%) followed by January (11.76%) and October (11.65 %), while it was the lowest in the month of March (10.78%) and September (10.89%).

**Fish juveniles**

In male, fish juveniles (11.48 %) were recorded in all the months. Maximum quantity was recorded in the month of January (16.83%) followed
by March (15.69%) and December (13.73%). Lowest quantity was recorded during April (5.83%). In case of female, they (10.93%) were noticed in all months. Higher quantity was recorded in the month of January (14.71%) followed by March (13.27%) and December (13.13%). Lowest quantity was recorded during September (7.84%).

**Teleosts**

In male, teleosts (3.59%) were slightly larger in size and hence could be identified. Of these, flatheads, flatfishes, *Saurida* spp, *Stolephorus* spp, *Leiognathus* spp. and *Nemipterus* spp. were dominant. Higher percentage of teleosts were recorded in April (7.77%) and February (5.94%) and lower percentage in the month of October (1.01%) and December (1.96%). In case of female, they (5.36%) were found in all the months with peak in the month of April (8.91%) and February (6.93%) and lower percentage in the month of October (2.91%) and December (3.03%).

**Squid juveniles**

In male, squid juveniles (2.62%) were recorded in all the months except in November with a peak in the month of May (4.81%) followed by December (3.92%) and lower percentage in the month of April (1.94%) and January (1.98). In case of female, squid juveniles (2.65%) were also recorded in all the months with a peak in the month of May (4.08%) followed by January (3.92%) and lower percentage in the month of November (0.98%) and October (1.94%).

**Octopus juveniles**

In male, octopus juveniles (2.29%) were recorded in all the months. Higher percentage was recorded in March (4.90%) and lower percentage in the month of September (0.99%). In case of female, they (2.22%) were also recorded in all the months except October. Higher percentage was recorded in March and May (4.08%), lower percentage in the month of September (0.98%) and December (1.01%).
Crab juveniles

In male, crab juveniles (1.85%) were recorded during all the months except in October and occurrence was in lesser proportion compared to other food items throughout the study period. Maximum quantity was recorded in the month of February (3.96%) followed by December (3.92%), lower percentage in the month of April (0.97%) and March (0.98%). In case of female, they (2.77%) were recorded in all the months. Higher percentage was recorded in March (5.10%) followed by February (4.95%) and lower percentage in the month of November and January (0.98%).

Cuttle fish juveniles

Cuttle fish juveniles (1.20%) in males were recorded in all the months except during January and April. This food item was recorded in lesser proportion compared to other food items during the study period. Higher percentage was recorded in September (1.98%) and lower percentage in the month of May (0.96%). In case of female, they (1.54%) were recorded in all the months. Higher percentage was in the month of November (2.94%) and lower percentage in the month of October (0.97%).

4.1.1.2. During September, 2006 - May, 2007 period

The qualitative and quantitative analysis of gut contents of *Priacanthus hamrur* during September, 2006 - May, 2007 showed more or less similar trend as that of previous year (2005-2006). In male, the gut content consisted approximately 3.67% teleosts, 10.38% fish juveniles, 3.13 % squid juveniles, 1.63% cuttle fish juveniles, 3.23% octopus juveniles, 2.49% crab juveniles, 36.36% shrimps, 14.70% crustacean remains and 24.49% semi-digested matter, while in female, the proportion of gut contents was 4.99% teleosts, 10.07% fish juveniles, 3.58% squid juveniles, 2.27% cuttle fish juveniles, 2.28% octopus juveniles, 3.37% crab juveniles, 38.97% shrimps, 11.81% crustacean remains and 22.65% semi-digested matter.
**Shrimps**

In males, shrimps (36.36%) were recorded in all the months with peak in October (44.89%) and September (42.16%). The lowest quantity of this item was found during May (30.48%). In case of female, shrimps (38.97%) were found in greater abundance during September (46.06%) and October (45.09%). The lowest quantity was found during March and May (33.66%). The various genera of shrimps could not be identified due to its autolysis condition but some could be identified and majority of shrimps recorded were *Penaeus* spp.

**Semi-digested matter**

Semi-digested matter (24.49%) in males formed the bulk of the stomach content next to shrimps. The highest quantity was recorded in the month of November (26.73%) followed by October (25.51%) and January (25.24%). The lowest quantity was recorded in the month of February (22.86%) followed by September and December (23.53%). In case of female, (22.65%) it was found in greater abundance during April (25.49%) followed by March (23.76%) and May (23.76%). The lowest quantity was recorded during September (18.45%). In most cases, food was in the digested condition, which may be due the delay in landing of the catch.

**Crustacean remains**

In male, crustacean remains (14.70%) were another important food item next to shrimps and semi-digested matter. They were reported in all the months with peak during April (20.39%) and May (17.14%), while it was lowest in the month of September (9.80%) followed by December (11.76%) and October (12.24%).

In case of female, crustacean remains (11.81%) were also recorded in all the months with a peak in the month of April (13.73%) followed by May (12.87%) and October (12.75 %), while it was the lowest in the month of December (8.74%) and November (11.43%).
**Fish juveniles**

Fish juveniles (10.38%) were noticed in males during all the months. Maximum quantity was recorded in the month of January (13.59%) followed by March (13.46%) and February (11.43%). Lowest quantity was recorded during April (6.79%) followed by September (8.82%) and November (9.90%). In case of female (10.07%), they were recorded in all months. Maximum quantity was in the month of January (13.46%) followed by March (11.88%) and December (11.65%). Lowest quantity was recorded during September (6.79%) followed by April (6.86%) and October (9.80%).

**Teleosts**

In male, they (3.67%) were mainly comprised of those, which were slightly larger in size and hence were identified. Of these, flatheads, flatfishes, *Saurida* spp, *Stolephorus* spp, *Leiognathus* spp and *Nemipterus* spp. were dominant. Higher percentage of teleosts were recorded in April (5.83%) followed by February (4.76%) and March (3.85%), lower percentage in the month of January (1.94%), followed by October (2.04%) and December (2.94%). In case of female (4.99%), they were recorded in all the months, maximum percentage was recorded in the month of April (7.84%) followed by May (6.93%) and March (4.95%). Lower percentage were recorded in the month of December (2.91%) followed by October (2.94%) and November (3.81%).

**Squid juveniles**

In male, squid juveniles (3.67%) were recorded in all the months with a peak in the month of May (5.71%), lower percentage in the month of November (0.99%) and February (1.90%). In case of female, squid juveniles (3.58%) were also noticed in all the months with a peak in the month of May (4.95%) and March (3.96%), lower percentage in the month of November (2.86%).
Octopus juveniles

Octopus juveniles (3.23%) in males were recorded in all the months. Higher percentage was recorded in March (4.81%) and May (4.76%), lower percentage in the month of October (1.02%). In case of female, they (2.28%) were recorded in all the months except during November. Higher percentage was recorded in May (3.96%) and February (3.92%), lower percentage in the month of December (0.97%) and October (0.98%).

Crab juveniles

In male, crab juveniles (2.49%) were recorded in all the months except during January. Maximum quantity was recorded in the month of December (4.90%) and February (3.81%), lower percentage in the month of March (1.92%) and April (1.94%). In case of female, they (3.37%) were recorded in all the months. Higher percentage was recorded in March (5.94%) followed by February (4.90%) and April (3.92%). Lower percentage was recorded in the month of November (1.90%) followed by January (1.92%) and October (1.96%).

Cuttle fish juveniles

Cuttle fish juveniles (1.63 %) were recorded in males all the months except in February. The food items recorded in lesser proportion compared to other food items during the study period. Higher percentage was recorded in September and December (2.94%), lower percentage in the month of January and April (0.97%) followed by October (1.02%). In case of female, they (2.27%) were recorded in all the months. Higher percentage was in the month of November (4.76%), lower percentage in the month of January (0.96%) and December (1.94%).

4.1.2. Food in relation to size

The details of percentage occurrence of various food items in the stomach contents of *Priacanthus hamrur* belonging to the various size groups
are given in Table 2A(i) & 2A(ii) and Fig. 2A(i) & 2A(ii) for the year September, 2005-May, 2006.

The analysis revealed that, in all the size groups starting from 15-16 cm to 32-33 cm food items such as shrimps, semi-digested matter, crustacean remains, fish juveniles, teleosts, squid juveniles, octopus juveniles, crab juveniles and cuttle fish juveniles were found in different proportions.

**Shrimps**

Shrimps were the most dominant in all the size groups, although they occurred in different proportions. In both the sexes, the highest percentage was recorded in the size group 30-31 cm and lowest percentage in the size group 15-16 cm. Female showed more affinity towards shrimps than the male and large size group (20-33 cm) showed higher percentage of shrimp food compared to small size group (15-21 cm).

**Semi-digested matter**

Semi-digested matter was the second main food item in both the sexes. They were also recorded in all the size groups with a peak in 15-16 and 16-17 cm size groups in male and female respectively. Lowest percentage was recorded in the size group 30-31 cm in male and in size group 25-26 cm in case of female.

**Crustacean remains**

Crustacean remains recorded in all the size groups in various proportion. In both the sexes highest percentage was noticed in 32-33 cm size group and lowest in 29-30 cm size group.

**Fish juveniles**

Fish juveniles were recorded in all the size groups except 32-33 cm in both sexes. Highest percentage was noticed in 29-30 cm size group and lowest
percentage was recorded in the size group 22-23 cm and 21-22 cm size group in male and female respectively.

**Teleosts**

Teleosts were recorded in all the size groups in males except 31-32 cm and 32-33 cm. The highest percentage was recorded in 15-16 cm followed by 16-17 cm. Lowest percentage was noticed in 19-20 cm followed by 26-27 cm. In case of female, teleosts recorded in all the size groups. The highest and lowest percentage were recorded in 14-15 cm and 31-32 cm respectively.

**Squid juveniles**

In male, squid juveniles were recorded in all the size groups except 17-18 cm, 28-29 cm, 30-31 cm, 31-32 cm and 32-33 cm. Highest percentage was noticed in 16-17 cm and lowest in 26-27 cm size group. In case of female, the squid juveniles were recorded in all the size groups except 28 - 29 cm, 30 - 31 cm and 32 - 33 cm. The maximum percentage was recorded in 15-16 cm size group and lowest in 26-27 cm size group. In both the sexes, cuttle fish juveniles, octopus juveniles and crab juveniles were prominently recorded from 17-18 cm size group onwards. They were absent in early and older size groups except 15-16 cm size group in case of female.

Table 2B(i) & 2B(ii) and Fig. 2B(i) & 2B(ii) give the sex wise percentage occurrence of various food items in different size groups during September, 2006-May, 2007.

The analysis revealed that, in all the size groups starting from 14-15 cm to 33-34 cm, food items such as shrimps, semi-digested matter, crustacean remains, fish juveniles, teleosts, squid juveniles, octopus juveniles, crab juveniles and cuttle fish juveniles were found in different proportions.

**Shrimps**

Shrimps were the most dominant food items in all the size groups, although they occurred in different proportions. In male highest percentage was
recorded in the size group 31-32 cm and lowest percentage in the size group 14-15 cm. In case of female, highest percentage was recorded in the size group 30-31 cm and minimum quantity was recorded in the size group 14-15 cm. Female showed more affinity towards shrimps than the male and large size group (21-33 cm) showed higher percentage of shrimp food compared to small size group (14-20 cm).

**Semi - digested Matter**

Semi-digested matter was the second main food item in both the sexes. They were recorded in all the size groups with a peak in 14-15 cm. Lowest percentage was recorded in the size group 30-31 cm in male and in size group 26-27 cm in case of female.

**Crustacean remains**

Crustacean remains were recorded in all the size groups in various proportions. Highest percentage was recorded in 32-33 cm and 19-20 cm size group in male and female respectively. Lowest percentage was recorded in the size group 16-17 cm in male and in size group 29-30 cm in case of female.

**Fish juveniles**

Fish juveniles were recorded in all the size groups except 32-33 cm in both sexes. Highest percentage was noticed in 29-30 cm size group and lowest percentage was recorded in size group 21-22 cm and 31-32 cm size group in male and female respectively.

**Teleosts**

In male, teleosts were recorded in all the size groups and the highest percentage was in 14-15 cm followed by 15-16 cm. The lowest percentage was noticed in 31-32 cm followed by 19-20 cm. In case of female, teleosts were recorded in all the size groups, highest and lowest percentage were in 14-15 cm and 31-32 cm respectively.
**Squid juveniles**

Squid juveniles were recorded in male specimen of all the size groups except 16-17 cm, 29-30 cm, 30-31 cm, 31-32 cm and 32-33 cm. Highest percentage was noticed in 23-24 cm and lowest in 28-29 cm size group. In case of female, the squid juveniles were recorded in all the size groups except 30-31 cm and 32-33 cm. The maximum percentage was recorded in 24-25 cm size group and lowest in 19-20 cm size group. In both the sexes, cuttle fish juveniles, octopus juveniles and crab juveniles were also recorded at smaller proportion. They were absent in early and older size groups.

**4.1.3. Feeding intensity**

The percentage occurrence of stomach in various degree of fullness during September, 2005- May, 2006 are presented in Table 3A(i) & 3A (ii) and Fig. 3A (i) & 3A (ii).

It can be seen from the table that, in male the proportion of fish which had actively fed was the highest in September (67.85%) followed by November (59.62%) and October (59.38%). Poor feeding was observed in the month of April (43.33%) followed by May (45.83%) and March (46.55%). The percentage of empty stomachs increased from February to May with peak in May (18.06%) and decreased thereafter.

Among female, the feeding activity was highest in September (63.16%) followed by October (60.86%) and November (54.76%). Poor feeding was observed in April (50.59%) followed by March (52.44%) and February (53.76%). The percentage of empty stomachs increased from January to May with peak in May (20.00%) and decreased after May.

Table 3B (i) & 3 B (ii) and Fig. 3B (i) & 3 B (ii) summarises the percentage occurrence of stomachs in various degree of fullness during September, 2006 – May, 2007.

It can be seen from the table that, in male the proportion of fish which had actively fed was the highest in September (65.00%) followed by October
(63.02%), November (58.51%) and January (54.55%). Poor feeding was noticed in February (50.00%) followed by March (51.62%), May (53.08%) and April (53.33%). The highest percentage of empty stomachs were observed in the months of February (13.95%) and May (12.35%).

Among female, the feeding activity was highest in September (64.60%) followed by October (59.80%), November (53.88%) and December (50.92%). Poor feeding was observed in May (44.12%) followed by April (48.45%), March (48.51%) and February (53.53%). The percentage of empty stomachs increased from February to May with peak in May (17.65%) and decreased thereafter.

Table 3C (i) & 3 C (ii) and Fig. 3C (i) & 3 C (ii) infers the percentage occurrence of stomachs in various degree of fullness with respect to size groups of the fish during September, 2005 – May, 2006.

Among male, percentage of actively fed fishes was highest in the size groups 16-17 cm (83.33 %) followed by 17-18 cm (70.59%), 15-16 cm (66.7%) and 30-31 cm (66.66%). Poor feeding activity was observed in the size groups 24-25 cm (61.60%) followed by 29 -30 cm (60.00%), 26 -27 cm (55.56%) and 27 -28 cm (53.57 %). Higher percentage of empty stomachs were recorded only in lower size groups and were in decreasing order with increase in size of the fish except in the size groups of 20 - 21 cm and 21 - 22 cm.

In case of female, percentage of actively fed fishes was highest in the size groups 16-17 cm (78.95 %) followed by 17-18 cm (76.46 %), 31-32 cm (72.73%) and 15-16 cm (70.00%). Whereas poor feeding was observed in the size group 29 -30 cm (64.28%) followed by 27 - 28 cm (55.26 %), 26 -27 cm (50.00%), 23-24 cm (48.72%) and 28-29 cm (47.83%). Higher percentage of empty stomach were observed only in lower size groups and were in decreasing order with increase in size of the fish.

Table 3D (i) & 3 D (ii) and Fig. 3D (i) & 3 D (ii) summarises the percentage occurrence of stomachs in various degree of fullness with respect to size groups of the fish during September, 2006 - May, 2007.
Among male, percentage of actively fed fishes was highest in the size groups 30-31 cm (68.42%) followed by 17-18 cm (64.71%), 31-32 cm (63.65%) and 32-33 cm (63.64%). Poor feeding activity was observed in the size groups 29-30 cm (64.28%) followed by 24-25 cm (60.34%), 33-34 cm (50.00%), 25-26 cm (51.61%) and 23-24 cm (51.51%). Higher percentage of empty stomachs were recorded only in lower size groups and were in decreasing order with increase in size of the fish.

Percentage of actively fed fishes in case of female was highest in the size groups 17-18 cm (72.92%) followed by 16-17 cm (70.83%), 33-34 cm (66.67%) and 31-32 cm (65.71%) and 14-15 cm (61.70%). Highest Percentage of empty stomachs were observed in the size groups 18-19 cm (25.00%) followed by 14-15 cm (23.40%), 15-16 cm (17.44%) and 19-20 cm (15.38%).

4.2. Fishery
4.2.1. Monthly catch trend

The monthly catch effort and catch rate of the big eye for the year September, 2005 – May, 2006 is given in Table 4 and shown in Fig.4

During September, 2005 – May, 2006 the monthly bulls eye landing ranged between 55,000 kg (February) and 1,81,000 kg (October) with annual catch of 8,73,000 kg. The monthly percentage contribution of big eye catch to the total catch varied from 0.675% (January) to 1.286% (October). The annual catch of Priacanthids during September, 2005 – May, 2006 was 8,73,000 kg. The mechanized fishing operations in this area remain suspended from June to August as per the restrictions imposed by the Government of Karnataka. The total effort varied from 762 (February) to 3345 (March) units with total annual effort of 21,549 units. The catch rate varied from 21.824 kg (March) to 78.136 kg (September) with an average of 40.512 kg.
During September, 2005 – May, 2006, the monthly minimum and maximum catches of Priacanthids varied from 42,000 kg (April) to 2,66,000 kg (December) with annual catch of 12,37,750 kg. The percentage contribution of big eye catch to the total catch fluctuated between 0.470% (April) and 2.670% (December). The effort ranged between 1,115 (May) and 3,031 (January) with a total of 17,892 units. The catch rate was maximum in the month of October (133.529 kg) and minimum in the month of March (16.187 kg) with an average of 69.179 kg.

4.2. Length-Weight Relationship

The main objective of studying the length-weight relationship of fishes are (i) to determine mathematical relationship between the two variables, so that if one is known the other could be estimated and (ii) to calculate the relative condition factor. In order to understand these aspects, monthly length-weight relationships of male and female *Priacanthus hamrur* were calculated using the formula, 

$$W = a L^b$$

and presented in Table 5 A and 5 B for the year 2005-2006 and 2006-2007 respectively. The calculated length-weight curve fitted to the data is shown in fig. 5.

Table 5 A gives the length-weight relationship of *Priacanthus hamrur* from September, 2005 to May, 2006. The relationship obtained are as follows.

For male, $\log W = -1.8666 + 2.9818 \log L$

Or

$$W = 0.0136 L^{2.9818}$$

For female, $\log W = -1.6816 + 2.8360 \log L$

Or

$$W = 0.0208 L^{2.8360}$$

Table 5 B shows that length-weight relationship of *Priacanthus hamrur* from September, 2006 to May, 2007. The relationship obtained are as follows.

For male, $\log W = -1.7725 + 2.9285 \log L$

Or

$$W = 0.0169 L^{2.9285}$$
For female, \( \log W = -1.6213 + 2.8015 \log L \)

Or
\( W = 0.0239 L^{2.8015} \)

Analysis of co-variance (Table 6) indicated that there is significant difference in the length-weight relationship between the two sexes. From the F-ratio, it is evident that there is significant difference among the regression coefficients between male and female. Thus, the length-weight relationship *Priacanthus hamrur* were considered as different and therefore a combined relationship could not be derived to represent both male and female.

Fig. 5 depicts the relation of weight on length. It is inferred from the plot that the length-weight relationship is non linear.

### 4.3. Relative Condition Factor

The relative condition factor \( K_n = \frac{W_o}{W_c} \) for both male and female fish using respective length-weight relationship were calculated. Table 7 A and 7 B represents the monthly average relative condition factor for male and female respectively. In each case, the weighed average for the whole period was also calculated.

#### 4.4.1. Seasonal variation in relative condition factor

The mean monthly values of relative condition factor (Kn) were used to study the variation in condition of the fish in different months. Table 7 A and Fig. 6 A shows the condition of the male and female in different months from September, 2005 to May, 2006.

In case of male, the \( K_n \) values were higher than the weighed average (1.0396) during January, March, April and May, while it was lower than the weighed average during September, October, November, December and
February. The lowest $K_n$ value was found during September (0.9836) and the highest during May (1.1365).

In case of female, the $K_n$ values were higher than weighted average (1.0485) during March to April, while it was lower than the weighted average during September to February. The lowest $K_n$ value was found during September (0.9524), and highest during May (1.1458).

The condition of male and female in different months from September 2006 to May 2007 is shown in Table 7B and Fig. 6B.

In case of male, the $K_n$ values were higher than the weighed average (1.0357) during February, March, April and May, while it was lower than the weighed average during September to January. The lowest $K_n$ value was found during October (0.9989) and the highest during May (1.1254).

In case of female, the $K_n$ values were higher than weighed average (1.0458) during March to April, while it was lower than the weighed average during September to February. The lowest $K_n$ value was found during October (0.9973) and highest during May (1.1377).

4.4.2. Size dependent fluctuations in the relative condition factor

The mean $K_n$ values of both sexes of fish in relation to size are presented in Table 8 A and Fig. 7A for the period September, 2005 to May, 2006.

The relative condition factor values for males showed that the condition remained low in the size range 15 to 16 cm followed by increase in the next three size groups. Thereafter, gradual decrease in $K_n$ values for size groups, 19-20 cm and 20-21 cm, followed by sudden increase in $K_n$ values from the size groups 21-22cm. Then there was decrease in $K_n$ values in the size groups from 22-23 cm to 25-26 cm. Thereafter, sudden increase in $K_n$ value from size groups 26-27 cm to 32-33 cm is evident.

In case of female, size range of 15 -16 cm exhibited low $K_n$ values. There was gradual increase in $K_n$ values in next three size groups. Thereafter,
decrease in Kn values for the size group 19-20 cm was noticed followed by sudden increase in the Kn value for the size range 20-21 cm and 21-22 cm. There was decrease in Kn values in the size groups from 22-23 cm to 25-26 cm. Thereafter, sudden increase in Kn values from size groups 26-27 cm to 32-33 cm was noticed.

Table 8 B and Fig. 7 B shows the mean Kn values of each size group of both male and female for the year September, 2006 to May, 2007.

The relative condition factor values for males showed that the condition remained low in the size range 14-15 cm followed by increase in the next three size groups. Thereafter, gradual decrease in Kn values for size groups, 18-19 cm and 19-20 cm was observed, followed by increased next size groups 20-21 cm and 21-22 cm. After this, again gradual decrease up to four size groups 22-23 cm to 25-26 cm, was observed followed by sudden rise in Kn value from size groups 26-27 cm to 33-34 cm.

In case of female, size range 14-15 cm recorded low Kn values, there was gradual increase in Kn values in next four size groups. Thereafter, decrease in Kn values for the size groups 19-20 cm and 20-21 cm was noticed followed by sudden increase in 21-22 cm size group, which decreased further in size group up to 27-28 cm. Thereafter gradual increase in Kn values from size group 28-29 cm onwards is evident.

4.4. Reproduction

The results of the studies on maturity, spawning, size at first maturity, fecundity and sex-ratio are presented below:

4.5.1. Maturity

4.5.1.1. Classification of maturity stages –Female

Stage I – Immature

The ovaries appear thin, triangular shape, opaque and light pink in colour. They extend up to 1/3rd of body cavity. Ova not visible to naked eye and
irregular in shape, transparent with clear nucleus. No yolk formation. The maximum size of ova recorded was 0.236 mm, the mode of the largest group of ova was at 0.116 mm.

**Stage II – Immature**

Ovaries flattened and pink in colour, occupying 1/3rd of the body cavity, ova not visible to naked eye. The maximum size of ova recorded was 0.302 mm with mode of the largest group at 0.176 mm.

**Stage III - Maturing - I**

Ovary in this stage appeared slightly larger and occupies about 1/2 of the body cavity, ovarian wall semi-transparent, ova visible to the naked eye through the semi-transparent ovarian wall. Intra-ovarian eggs completely opaque with deposition of yolk. The maximum size of ova is 0.438 mm, the mode of the largest group being at 0.234 mm.

**Stage IV - Maturing - II**

Ovaries of this stage occupy nearly ¾th of the body cavity. They appear yellowish in colour. The ovarian wall thin and some ova visible through the wall. Blood vessels seen on dorsal side of the ovary. The maximum size of ova was at 0.472 mm, the mode of largest group was at 0.305 mm.

**Stage V – Mature**

Ovaries yellow in colour occupying about the full length of the body cavity. Blood vessels prominent. The ovarian wall thin and transparent. The maximum size of ova was 0.535 mm, the mode of largest group being at 0.372.

**Stage VI – Running/ oozing**

Ovary is very much enlarged, swollen, yellow in colour and occupy entire body cavity displacing the alimentary canal. The ovarian wall very thin and transparent. Blood vessels prominent and even slight pressure extrudes
eggs. Intra-ovarian eggs are large, transparent with single oil globule, free from follicle, perivitelline space prominent. The maximum size of ova was 0.645 mm and the mode of largest group ova was at 0.474 mm.

**Stage VII – Spent**

Ovaries dull reddish, shrunken, much reduced in size, occupying not more than ½ length of the body cavity. Maximum size of ova varied and few denatured ova often occurred. The maximum size of ova was 0.645 mm and the mode of the largest group of ova was at 0.043 mm.

**4.5.1.2. Classification of maturity stages – Males**

**Stage I – Immature**

Testes are thin triangular, with the anterior end tapering. The testes extend up to 1/3rd of the body cavity.

**Stage II – Immature**

Testes opaque, roughly triangular and pointed anteriorly.

**Stage III – Maturing – I**

Testes slightly enlarged and occupying about 1/2 of the body cavity, cream coloured.

**Stage IV – Maturing – II**

Testes much enlarged, opaque, thick, roughly triangular.

**Stage V – Mature**

Testes whitish in colour, triangular and occupying about full length of the body cavity.
Stage VI – Running

Identical to stage V but very much enlarged in size.

Stage VII – Spent

Testes are shrunken, reduced in size, dull creamy in colour.

4.5.1.3. Development of ova to maturity

Typical ovaries belonging to seven stages of maturity described above were selected and the ova diameter frequency polygons of these ovaries were drawn. The data are presented in Table 9 and Fig. 8.

In stage I, the size of ova ranged from 0.116 mm to 0.236 mm, majority of them ranging in size from 0.116 mm to 0.176 mm. There is only one batch of immature ova with a mode at 10 Occular Micro Division (OMD), while in stage II, the ova diameter had increased with the mode shifted to 1.8 mm. The maturity group had a model value at 0.234 mm, while the largest ova measured 0.438 mm. As development progressed in stage III, this mode shifted to 2.2 mm. In stage IV, this progressed to 0.305 mm, the maximum size being at 0.472 mm. The mode at 2.2 mm, progressed to 3.0 mm with a secondary mode at 1.8 mm. In stage V, the ova ranged from 0.372 mm to 0.535 mm, although the major mode shifted to 3.8 mm., the secondary mode was observed at 2.6 mm. In stage VI, this progressed to 0.474 mm, the maximum size being 0.645 mm. The mode at 3.8 mm progressed to 4.6 mm with a secondary mode at 2.2 mm. In stage VII, there was a mode at 0.116 mm, maximum size of ova being 0.316 mm. This stage resembled I or II stage, only immature ova were discernible with mode at 1.4 mm. Fish seems to remain in this condition until the maturation cycle commences again.
4.5.2. Spawning habits

4.5.2.1. Spawning season

The spawning season was determined on the basis of occurrence of individuals in mature, running and spent stages of maturity in each month. The seasonal changes in occurrence of gonads of *Priacanthus hamrur* in different stages of maturity are presented in Table 10 A and Figures 9 A (i) & 9 A (ii) for the year September, 2005 to May, 2006 and in Table 10 (B) and Figures 9 B (i) & 9B(ii) for the year September, 2006 to May, 2007 respectively.

**September, 2005- May, 2006**

**Male**

The results of the gonadal maturity of male during September showed only I, II, III and VII stages. Stages I and II most predominant. In October I, II, III and IV stages were present; I and II stages being predominant. In November I, II, IV and V stages were present, I and II stages were dominant but the presence of stage IV and V increased compared to previous month.

December and February showed only I, II and III stages but the percentage of stage I and II increased compared to previous months. In January, only stage I and II were noticed. In March, all the stages were recorded except IV and VII stages. In April and May all the stages were observed except VII stage, the percentage of stage I, II and III decreased, while the percentage of stage IV, V and VI increased.

In case of female, stage I, II III and VII were recorded in September with dominance of stage I and II. In October and November, stage IV and V made their appearance though stage I and II were dominant. In December and January, stage I, II and III were present, the percentage of stage I and II increased compared to previous months. The maturity stages I to IV were recorded during February, the dominant being stage I. In the months of March, April and May, all the six stages were observed. While during these months
stage I, II and III decreased compared to previous months where, stage IV, V and VI showed increasing trend.

During the year September, 2006-May, 2007, a similar trend was observed with respect to the proportion of gonads of *Priacanthus hamrur* with a slight difference in percentage occurrence of each stage during the respective months.

The results of the gonadal maturity of male during September showed only I, II, III and VII stages. Stages I and II were the most predominant. In October I, II, III, IV and VII stages were noticed; I and II stages being predominant. In November all stages were present except VII. In the same month I and II stages were again dominant, stages IV, V and VI stages registered in higher percentage compared to previous months.

In December and February, only I, II, III, IV stages were noticed. The percentage of stage I and II increased compare to previous months except in September. In January, only I, II and III stages were noticed, stage I and II being predominant. In March and April, all the stages were recorded except VII stage. In May, all the seven stages were observed, the percentage of stage I, II and III being less frequent, while the percentage of IV, V and VI stages showed increased trend.

In case of female, stage I, II, III and VII were noticed in September with dominance of stage I and II. In October, stage IV, V and VI made their appearance though stage I and II were dominant. In the month of November, five stages were recorded, I and II being dominant. In December, only four stages were noticed, II and I were most dominant. In January only I, II and III stages were recorded, I and II stages being dominant. Maturity stages I to IV were recorded during February, dominant being stage I. In the month of March all six stages were observed, stages IV, V and VI recorded more frequently. In the month of May, all seven stages were recorded, stage I, II, III however, were less frequent compared to previous months where, stage IV, V and VI showed increased trend.
4.5.3. Size at first maturity

For the determination of size at first maturity of *Priacanthus hamrur* a total number of 1247 male and 1615 female samples were examined by obtaining from main fish landing center and fish markets of Mangalore during September, 2005 to May, 2007.

4.5.3.1. Relationship between the size of the fish and maturity

Fishes were grouped sex-wise into one cm size groups and the details of percentage occurrence of fish in various maturity stages were calculated. Fish from stage IV onwards were considered as mature. The data are presented in Table 11 A and 11 B.

From Table 11A, it could be seen that all the males up to 17 cm were in immature stage (stage I, II and III). Above 17 cm size onwards mature fish started appearing. In the size group 17-18 cm, about 47.05% of mature fish were observed. More than 50% of fishes were found to be mature (52.63%) in the size group of 18-19 cm. From this group onwards, mature fishes gradually increased to reach 100% at 31-32 cm and 32-33 cm size groups. From the above data, the size at first maturity for male fish appeared to be 18-19 cm TL.

In case of female (Table 11A), all the fishes were immature up to 18 cm. In 18-19 cm size group, 26.08% mature fish were found. In the size group 19-20 cm, most of the fish were found to be mature (50.67%). From this group onwards the percentage of mature fish gradually increased and reached 100% at 32-33 cm size group. Based on the above data, the size at first maturity for females appears to be 19-20 cm.

From Table 11B, it is evident that all the male up to 16 cm were in immature condition (stage I and II). Mature fish start appearing at about 17 cm size onwards. In the size group 16-17 cm, about 31.91% of mature fish were observed. More than 50% of the fishes were found to be mature (57.29%) in the size group 18-19 cm. From this group onwards, mature fishes gradually
increased to reach 100% at 32-33 cm and 33-34 cm size groups. From the above data, the size at first maturity for male appears to be 16-17 cm.

In case of female (Table 11B), all fishes were immature up to 17 cm. In 17-18 cm size group, 25% were found to be matured. In the size group 19-20 cm, most of the fish were mature (64.62%). From this group onwards the percentage of mature fish gradually increased to 100% at 33-34 cm size group. Based on the above data, the size at first maturity for females appears to be 17-18 cm.

In order to determine the size at first maturity, the distribution of the cumulative percentage of IV to VI stages were considered. For this purpose cumulative percentage frequencies of fishes belonging to the above stages were plotted against size groups. The size at 50% cumulative percentage was considered to indicate the overall reproductive maturity of the population as a whole. As seen from the Table 12 and Fig. 10 A and 10 B, it is clear that during September, 2005 to May, 2006, the male and female mature at 21.50 and 22.50 cm respectively while, in the subsequent year size at first maturity was found to be 21.50 and 22.50 for male and female respectively (September, 2006 to May, 2007.)

4.5.3.2. Size at first maturity as determined from relative condition factor

The mean relative condition factor, $K_n$ with respect to size was made to use to find out the size at first maturity. Mean $K_n$ values for each mid-class length was plotted against the respective size (Fig. 7 A and 7 B). From the Figure, it can be seen that the size at first maturity of *Priacanthus hamrur* was at 21-22 cm for male and female 22-23 cm in both the years.

4.5.3.3. Size at first maturity with 95% confidence

The size at first maturity was also determined using the method described by Udupa (1986). The details of data are given in Tables 13 A (i), 13A (ii) and 13 B (i), 13 B (ii) during the year September, 2005- May, 2006. The size at first
maturity was 21.21 cm for male with 95 % confidence limits ranging between 22.52 cm and 22.54 cm. In case of female, the size at first maturity was 22.31 cm with 95 % confidence limits ranging between 23.62 cm and 23.65 cm.

During September, 2006 to May, 2007, it was found that male attained maturity at size 21.29 cm with 95 % confidence limit ranging between 22.60 and 22.63 cm. While female attained maturity at size 22.61 cm with 95 % confidence limits ranging between 23.95 and 23.98 cm.

4.5.4. Gonado-Somatic Index (GSI)

In this study, both sexes were treated separately. The GSI was calculated for each individual fish and was averaged for each month. The average GSI values were plotted against each month. The results are given in Table 14 A & 14 B and Fig. 11 A & 11 B.

During September, 2005 – May, 2006, the GSI values of male ranged between 0.4866 and 2.6348. The lowest GSI value was recorded in January, while the highest in May. The GSI values gradually increased from February to May and declined in the month of September, thereafter the GSI values increased in the months of October and November.

In case of female, the GSI values fluctuated between 0.9542 and 3.8214. The lowest GSI value was in January, while the highest was recorded in the month of May. The GSI values gradually increased from February to May and then suddenly declined in the month of September, thereafter the GSI values increased in the months of October and November.

During the year September, 2006 – May, 2007, the GSI values of male ranged between 0.5463 and 2.8346. The lowest GSI value was recorded in January, while the highest during May. The GSI values gradually increased from February to May and declined in the month of September, thereafter the GSI values increased during October and November.

In case of female, the GSI values fluctuated between 0.9864 and 3.9816. The lowest GSI was in January, while the highest was recorded in the month of May. The GSI values gradually increased from February to May and suddenly
declined in the month of September, thereafter the GSI values increased in the months of October and November.

4.5.5. Fecundity

Only the mature ova were considered for the estimation of fecundity. In *Priacanthus hamrur*, a clear demarcation of mature and immature ova was noticed from IV stage onwards. Hence, for fecundity studies, of stage IV, V and VI were taken into consideration. Fecundity was estimated by counting the number of ova in a small portion of the ovary of known weight and computing the total number of ova based on this count and total weight of ovary. Three portions were taken from each ovary from the anterior, middle and posterior parts, and an estimate was made of mean egg weight of each ovary from the samples taken.

The details of the fecundity studies are presented in Table 15. Fecundity ranged from 1,57,268 to 4,13,648 eggs with an average of 2,53,917 eggs. The minimum weight of the mature *Priacanthus hamrur* was 98 g and the maximum weight 385 g with length varying between 19.80 cm to 32.50 cm TL respectively. The number of ova increased generally with increase in length and weight. However, variations in fecundity with respect to length and weight were also noticed.

4.5.5.1. Relationship between fecundity and length of fish

When logarithmic values of fecundity (Y) were plotted against logarithmic values of length (X), it showed a linear relationship between the two variables (Fig. 12 a). The relationship between length and fecundity was found to be

$$Y=3.2870 + 1.4913 \times X$$

Where, Y = Log. Fecundity and X = Log. Length of fish
The correlation co-efficient “r” calculated from the logarithmic values of these two variables was found to be 0.92.

### 4.5.5.2. Relation between fecundity and weight of fish

The relationship between the weight (W) and the fecundity (F) of *Priacanthus hamrur* (Fig. 12 b) was linear. The linear form of regression between weight of fish and fecundity was calculated as

\[
Y = 4.1252 + 0.5464 \times X
\]

Where, \( Y = \text{Log. F} \) and \( X = \text{Log. W} \)

The correlation co-efficient “\( r \)” between fecundity and weight of fish was found to be 0.9182

### 4.5.5.3 Relationship between fecundity and gonad weight

The logarithmic values of fecundity (Y) when plotted against logarithmic gonad weight (X) of the fish (Fig.12 c) indicated a linear regression equation of the form \( Y = A + BX \). The calculated regression equation was given by

\[
Y = 4.5215 + 0.9307 \times X
\]

Where, \( Y = \text{Log. F} \) and \( X = \text{Log G} \)

The correlation co-efficient “\( r \)” between fecundity and weight of ovary was 0.9402

### 4.5.6. Sex-ratio

For studying sex ratio, a total of 1,126 specimens during September, 2005 – May, 2006 and 1,736 specimens during September, 2006 – May, 2007 were examined ranging in total length from 14-15 cm to 33-34 cm size groups.
Data on the sample number of male and female in different months are given in the Table 16 and Fig. 13. Chi-square test was applied in order to ascertain any significant difference in sex – ratio in the monthly samples.

Table 16 represents data on sex - ratio of *Pricanthus hamrur* with respect to different months. Predominance of female was noticed throughout the period of the study. Chi-square values at 5 % probability level during September, 2005 – May, 2006 period showed that there was significant difference in the sex ratio of all the months except during September, October, January and may. The pooled sex - ratio (M: F) was found to be 1: 1.46, which was statistically significant at 5 % level.

During September, 2006-May, 2007, significant difference in sex - ratio was noticed only in the month of October whereas, in other months there was no significant difference. The pooled sex-ratio (M:F) was found to be 1:1.20 which was significant at 5% level.

The data were also analyzed by Chi-square test to test the number of male and female in various size groups. It is clear from the Table 17 and Fig. 14 that during September, 2005 to May, 2006 period female dominated over male except in the size groups 22 – 23 cm, 24 – 25 cm, 26 -27 cm, 29 -30 cm. At 0.05 probability level, the size groups 16 – 17, 18 – 19, 19 – 20, 24 -25, 25 -26, 31- 32 and 32 - 33 cm TL indicated significant difference in chi-square value in the number of male and female.

It is clear from the Table 17(B) and Figure 15 that during September, 2006-May, 2007 period female were dominated over male except in the size groups 14-15 cm, 17-18 cm, 18-19 cm, 19-20 cm, 24-25 cm and 27-28 cm. At 0.05% probability level, the size groups 16-17 cm, 25-26 cm and 29-30 cm TL indicated significant difference in Chi-square value in the number of male and female.

4.6. AGE AND GROWTH
4.6.1. Length frequency distribution data

The length measurements of fish were divided into class intervals of one cm size TL. The percentage frequencies were calculated and plotted against the size groups in the form of frequency polygon for each month.

The sex wise length frequency distribution of *Priacanthus hamrur* in various size groups for different months during September, 2005 – May, 2006 are given in Table 18 A and 18 B and Fig. 15 A  and 15 B.

**September, 2005 – May, 2006**

i) Male

It is evident from the Fig.15 A that during the months of October and November, two modes were observed at 19-20 cm, 24-25 cm and 18-19 cm, 24-25 cm respectively. Three modes could be seen during the months of September, December, January and April at 20-21 cm, 23-24 cm, 27-28 cm; 19-20 cm, 24-25 cm, 29-30 cm; 17-18 cm, 24-25 cm, 28-29 cm and 14-15 cm, 24-25 cm, 29-30 cm respectively. During February four modes were found at 20-21 cm, 24-25 cm, 27-28 cm and 29-30 cm. While in March five modes were recognized at 18-19 cm, 22-23 cm, 25-26 cm, 27-28 cm and 29-30 cm. In the month of May, six modes were traced at 16-17 cm, 18-19 cm 22-23 cm, 24-25 cm, 27-28 cm and 31-32 cm.

ii) Female

It can be seen from Fig. 15B that in October and March three modes were observed at 16-17 cm, 19-20 cm, 25-26 cm and 15-16 cm, 24-25 cm, 27-28 cm respectively. During September and January four modes could be observed at 15-16 cm, 21-22 cm, 24-25 cm, 27-28 cm and 18-19 cm, 20-21 cm, 25-26 cm, 27-28 cm respectively. In November, December, February and May five modes were traced each at 15-16 cm, 19-20 cm, 25-26 cm, 27-28 cm, 32-33 cm; 18-19 cm, 20-21 cm, 25-26 cm, 27-28 cm, 32-33 cm 18-19 cm, 20-21 cm, 25-26 cm, 27-28 cm, 31-32 cm and 16-17 cm, 19-20 cm, 23-24 cm, 25-
26 cm, 31-32 cm respectively. In the month of April, six modes were noticed at 16-17 cm, 18-19 cm, 20-21 cm, 25-26 cm, 27-28 cm and 31-32 cm.

The sex wise length frequency distribution of *Priacanthus hamrur* in various size groups for different months during September, 2006 – May, 2007 are presented in Table 18 C and 18 D and Fig. 15 C and 15 D.

**September, 2006 – May, 2007**

**i) Male**

It is clear from the Fig. 15C that in September, October and April three modes each could be recognized at 15-16 cm, 19-20 cm, 23-24 cm; 18-19 cm, 24-25 cm, 28-29 cm and 18-19 cm, 24-25 cm and 31-32 cm respectively. In February four modes were observed at 15-16 cm, 18-19 cm, 22-23 cm and 24-25 cm. In November and May five modes each could be observed at 15-16 cm, 18-19 cm, 20-21 cm, 24-25 cm, 26-27 cm and 16-17 cm, 18-19 cm, 21-22 cm, 27-28 cm and 30-31 cm respectively. In December, January and March six modes were traced each at 16-17 cm, 20-21 cm, 24-25 cm, 27-28 cm, 30-31 cm, 32-33 cm; 18-19 cm, 20-21 cm, 22-23 cm, 24-25 cm, 27-28 cm, 29-30 cm and 15-16 cm, 18-19 cm, 21-22 cm, 24-25 cm, 27-28 cm, 31-32 cm respectively.

**ii) Female**

It is evident from the Fig. 15D that three modes were observed at 19-20 cm, 28-29 cm and 32-33 cm during October. In November four modes were found at 15-16 cm, 18-19 cm, 25-26 cm and 27-28 cm. During September, December, February and April five modes were traced at 15-16 cm, 18-19 cm, 22-23 cm, 24-25 cm, 27-28 cm; 16-17 cm, 18-19 cm, 22-23 cm, 24-25 cm, 31-32 cm; 15-16 cm, 20-21 cm, 25-26 cm, 27-28 cm, 31-32 cm and 15-16 cm, 18-19 cm, 20-21 cm, 25-26 cm, 31-32 cm respectively. In January, March and May six modes were observed each at 15-16 cm, 17-18 cm, 20-21 cm, 25-26 cm, 27-28 cm, 31-32 cm respectively.
From the length frequency data, it was difficult to follow the progression of modes to determine the age and growth of fish. Hence, ELEFAN software was used to determine the growth rate and age of fish.

**4.6.2. Mean length at age**

Table 19 and Fig.16 gives the mean length of *Priacanthus hamrur* at different ages. Male and female attained 12.02 cm, 18.85 cm and 23.56 cm; 13.83 cm, 21.14 cm and 25.80 cm at the end of 1, 2 and 3 years respectively. It is evident from the data that the younger age groups showed faster growth rate than the older age groups. In 4, 5, 6, 7 and 8 years, male recorded the growth rate of 26.82 cm, 29.07 cm, 30.63 cm, 31.70 cm and 32.44 cm while, female recorded the growth rate of 28.77 cm, 30.67 cm, 31.87 cm, 32.64 cm and 33.14 cm respectively.

**4.6.3. Growth equation**

From the biological point of view, to understand any fish population it is necessary to fit the growth equation with respect to length or weight. These may form the basis for calculations leading to the knowledge of the growth, mortality, recruitment and other fundamental parameters of population. These parameters are further used for evolving effective management strategies for the development and judicious exploitation of fisheries resources.

The length at age data obtained by Electronic Length Frequency Analysis (ELEFAN) and Pauly’s method were used to estimate the parameters of Von-Bertalanffy growth equation.

Table 20 provides the growth parameters obtained for the male and female of *Priacanthus hamrur*.

Fig.17 A and 17 B shows the restructured length-frequency showing peak growth curve and maximum $R_n$ value estimated for male.
The Von-Bertalanffy growth equation may be expressed as

\[ L_t = 34.10 \left[ 1 - e^{-0.37 (t+0.1743)} \right] \]

The restructured length frequency (Fig. 18A and 18B) shows the peak growth curve and maximum Rn value estimated for the female.

\[ L_t = 34.00 \left[ 1 - e^{-0.45 (t+0.1606)} \right] \]

Similarly Fig. 19A and 19B shows the restructured length frequency of sexes pooled in peak growth curve and the maximum Rn value estimated for both sexes. The fitted growth equation may be expressed as

\[ L_t = 34.20 \left[ 1 - e^{-0.40 (t+0.1689)} \right] \]

The growth parameters obtained from different methods are presented in Table 20 and Fig. 18

\( L_\infty \) and K values obtained from Ford-Walford plot (Fig. 18) were 34 cm and 0.3640 for male, while for female, the values were 35 cm and 0.4245 respectively.

Gulland and Holt plot gave \( L_\infty = 34.50 \) cm for male and 35.00 cm for female. The values of \( t_o \) obtained from Beverton and Holt plot were \(-0.2\) for male and female. Pauly’s empirical relation gave \( t_o = -0.1743 \) for male and \( t_o = -0.1606 \) for female.

4.7. Population dynamics

4.7.1. Mortality rates

The estimated values of total, natural and fishing mortality rates of *Priacanthus hamrur* are provided in Table 21A & 21B and Fig. 20.

It is seen from the slope of the descending line of the Length-converted catch curve (Fig.20) that the total mortality coefficient for *Priacanthus hamrur* was 1.44. The natural mortality coefficient for *Priacanthus hamrur* was found to be 0.91.

By subtracting the natural mortality coefficient from the total mortality coefficient the fishing mortality coefficient for *Priacanthus hamrur* was found to be at 0.53.
The average exploitation ratio (E) and exploitation rate (U) for *Priacanthus hamrur* were 0.37 and 0.28 respectively.

### 4.7.2. Probability of capture (Lc)

The estimated probability of capture (Lc) are shown in the Fig. 21. The data were corrected for selection using selection parameters. Length at which 25 per cent of fish will be vulnerable to the gear was 19.38 cm, while length at which 50 per cent of fish will be vulnerable to the gear was 23.29 cm and L_{75} was at 28.10 cm.

### 4.7.3. Relative yield per recruit and biomass per recruit

The relative yield per recruit and biomass per recruit are presented in Table 22 and Fig.22. From the relative yield per recruit diagram, it is seen that the maximum yield could be obtained when the exploitation ratio is 0.37, the relative biomass will be reduced to 52% of the exploited phase.

### 4.7.4. Biomass, yield and fishing effort multiplier

The relation between biomass, yield and fishing effort multiplier is provided in Table 23. and Fig. 23. The present level of biomass and yield were recorded as 43,890 t and 1,055 t respectively.

The exploitation ratio of 0.37 (lessen than 0.5) obtained for commercial landings data, based on the present level of exploitation of the stock of *Priacanthus hamrur* off Mangalore coast indicated that stocks are not being exploited even to optimum level during recent years.