Biological Aspects of Economic Fishes in the Bay of Bengal

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Abstract

Six dominant large sized fish species, *Katsuwonus pelamis*, *Xiphias gladius*, *Auxis thazard*, *Alopias superciliosus*, *Carcharhinus falciformis* and *Coryphaena hippurus* are economic important fishes in the Bay of Bengal which were chosen to study on biological aspect. The fish samples from 21 stations were obtained from drift gill net and pelagic long line operated by M.V. SEAFDEC during 25 October-21 December 2007 in the Bay of Bengal. The results showed that the average size of *K. pelamis* was 41 ± 10.19 cm whereas *X. gladius*, *A. thazard*, *A. superciliosus*, *C. falciformis* and *C. hippurus* were 211.00 ± 46.36, 35.14 ± 4.86, 271.00 ± 40.25, 111.33 ± 8.79 and 72.94 ± 12.58 cm respectively. The relationship between length and body weight showed high significant correlation in all respected species. There was significant difference in sex ratio of *K. pelamis* ($p<0.05$) but none in others species ($p>0.05$). The study of gonad development in this survey could not use to indicate the spawning season due to less specimens and the survey did not cover all year round.

Key words: Bay of Bengal, economic fishes, sex ratio, gonad development

Introduction

The Bay of Bengal, a sea in the north-east arm of the Indian Ocean, is located between 5°N-22°N latitudes and 80°E-100°E longitudes. Fisheries are of major socioeconomic importance to all countries bordering the bay. The main commercial fish species are shrimp, tuna, yellowfin tuna, bigeye tuna and skipjack tuna. There is a high percentage catch for miscellaneous coastal fishes and pelagic fishes, however shrimp is the major export earner in this region. The Food and Agriculture Organization (FAO) 10 years trend showed a steady increased in catch from 1.4 million tons in 1990 to 2.2 million tons in 1999. An average catch was 2 million tons. Catch trends were quite diverse and it was difficult to identify a pattern due to the fact there was inadequate information on the status of the fishery resources and their exploitations. There were signs that the harvest levels may not be sustainable, especially with regard to tuna fishing in the Maldives, Malaysia, Andaman coast of Thailand and Sri Lanka. Furthermore, the most of countries surrounding the bay are weak in developing clear policies, appropriate strategies and the sustainable management of the fishery resources (NOAA. http.// na.nefsc.noaa.gov/lme/text/lme 34 htm; FAO, 2003).

Therefore, the study on biological aspects (e.g. length and weight relationship, sex ration and maturation) is very useful and essential for fishery enhancement and management. It will support future fishery development with scientific data for not only conservation of the fishery resources but also appropriate fishery management for sustainable fishery in the Bay of Bengal.

Materials and Methods

Six dominant species of pelagic fish, *Katsuwonus pelamis*, *Xiphias gladius*, *Auxis thazard*, *Alopias superciliosus*, *Carcharhinus falciformis* and *Coryphaena hippurus* were collected from drift gill net (8 stations) and pelagic longline (13 stations) operated in the Bay of Bengal by M.V. SEAFDEC, a vessel of the Southeast Asian Fisheries Development Center, during 25 October-21 December 2007 (Fig.1). All sampled fishes were examined, measured and weighted on board in a fresh condition. Some biological parameters were recorded and analyzed as follow:

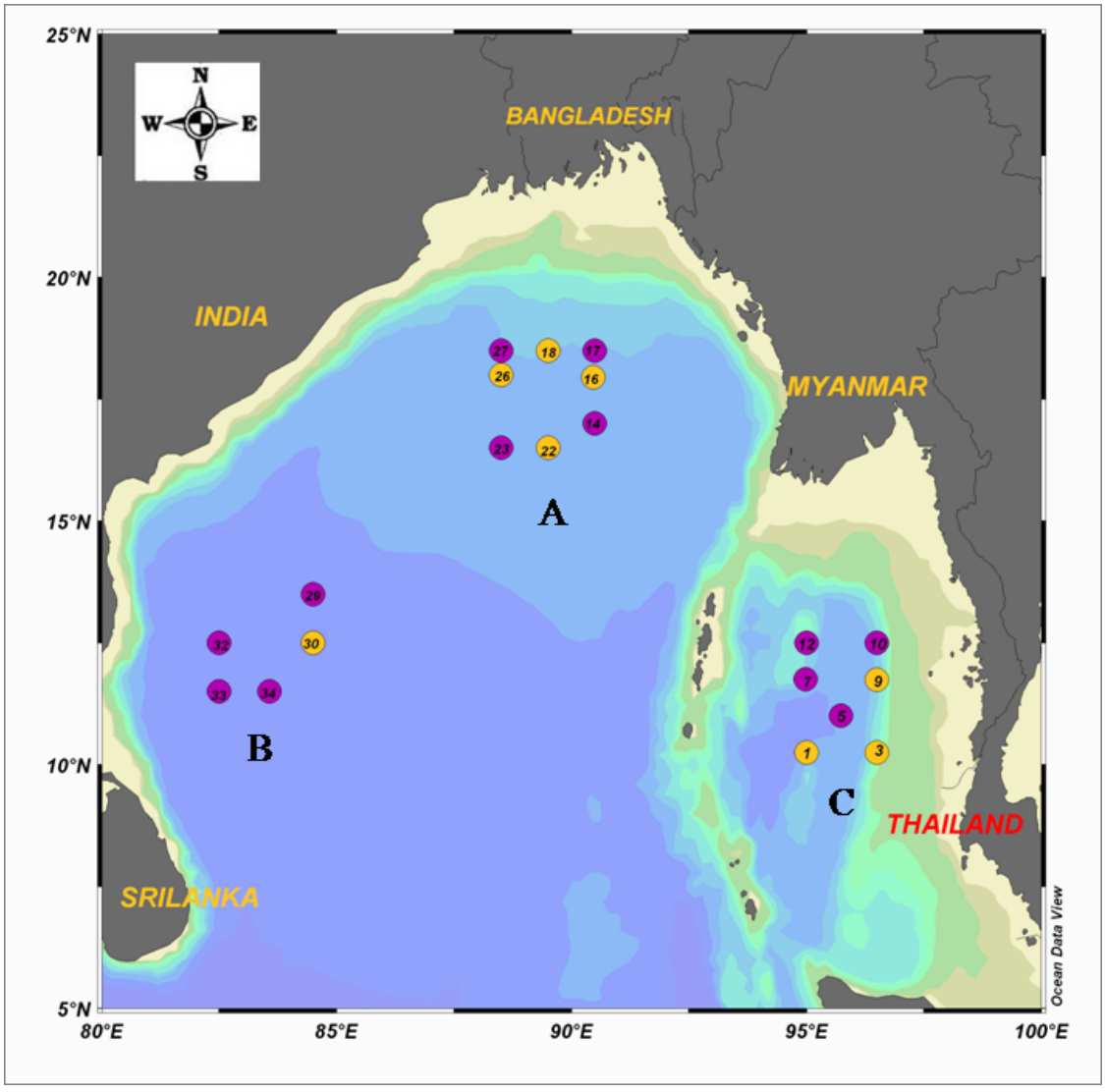

Figure 1 Survey and sampling stations of the six dominant species in the Bay of Bengal.
- Drift gill net
- Pelagic longline

1. Length Frequency Distribution

Both fork length and total length were measured in centimetre (cm) and illustrated as histogram via length interval and frequency. The average, maximum and minimum size of fishes were also figure out.

2. Length-Weight Relationship

All sampled fishes were measured and weighted in a fresh condition. Fork length and total length were measured in centimetre (cm) and the weights were recorded in kilogram (kg). The relationship equations of length-weight of these six species were estimated using the regression analysis (Ricker, 1975). In the analysis process, length and weight data were transformed into logarithms.

$$W = a L^{b}$$

$$\log W = \log a + b \log L$$

W = body weight (kg)
L = total length or fork length (cm)
a, b = output from regression line (b is slope)

3. Sex Ratio

Hypothetically, the sex ratio of male to female equals to 1:1 which is significant at 95% of confident level. All data were analysed using Chi-square test.

$$\chi^2 = \frac{\Sigma\left(\left|\text{Observed} - \text{Expected}\right| - 0.5\right)^2}{\text{Expected}} \qquad (n < 50)$$

χ^2 = Chi – square
Observed = number of male (female)
Expected = average between male and female

4. Maturation

Male and female sexual maturities were determined from gonad development which are categorized into 6 stages.

Stage 1 Virgin. Very small sexual organs close to the vertebral column. Testis and ovary transparent, colorless grey. Egg invisible by naked eye.

Stage 2 Maturing virgin and recovering spent. Testis and ovary translucent, grey red. Length half, or slightly more than half the length of ventral cavity.

Stage 3 Developing. Testis reddish-white. No milt drops appear under pressure. Ovary organ reddish, egg clearly discernible of opaque. Testis and ovary occupy about two-thirds of central cavity.

Stage 4 Developed. Testis and ovary opaque, reddish with blood capillaries, occupy about half of ventral cavity. Eggs visible to eye as whitish granular.

Stage 5 Spawning. Roe and milt with slight pressure. Most eggs translucent with a few opaque eggs left in cavity.

Stage 6 Resting. Testis and ovary empty, red. A few eggs in the stage reabsorption.

Stages 1-3 are immature and stages 4-6 are mature stage.

Results and Discussion

Six dominant species of pelagic fish obtained from drift gill net and pelagic long line operation in the Bay of Bengal, were consisted of *K. pelamis*, *X. gladius*, *A. thazard*, *A. superciliosus*, *C. falciformis* and *C. hippurus*. They are economic important fish and abundant in the surveyed area these species were taken for biological analyses. The results were as follow:

1. Size Frequency Distribution

The analyzed data and histogram are shown in table 1 and fig. 2.

Skipjack tuna, *K. pelamis*, was the top most species caught in this study. Fork length ranged from 17.80-70.00 cm, the average size was 41.46±10.19 cm.

Swordfish, *X. gladius*, was the second dominant species. The average, minimum and maximum sizes were 211.00±46.36, 129.00 and 295.00 cm respectively. The rest of the caught fishes were observed as shown in table 1 and fig. 2 either.

Table 1 Size range including mode and mean sizes of the six dominant species.

Species	n	Minimum (cm)	Maximum (cm)	Mode (cm)	Mean±SD (cm)
Katsuwonus pelamis (FL)	38	17.80	70.00	40.00	41.46±10.19
Xiphias gladius (TL)	17	129.00	295.00	162.00, 212.00	211.00±46.36
Auxis thazard (TL)	11	25.60	40.00	38.00	35.14±4.86
Alopias superciliosus (TL)	9	205.00	331.00	250.00	271.00±40.25
Carcharhinus falciformis (TL)	9	85.00	178.00	93.00	111.33±8.79
Coryphaena hippurus (TL)	9	62.00	97.00	66.00	72.94±12.58

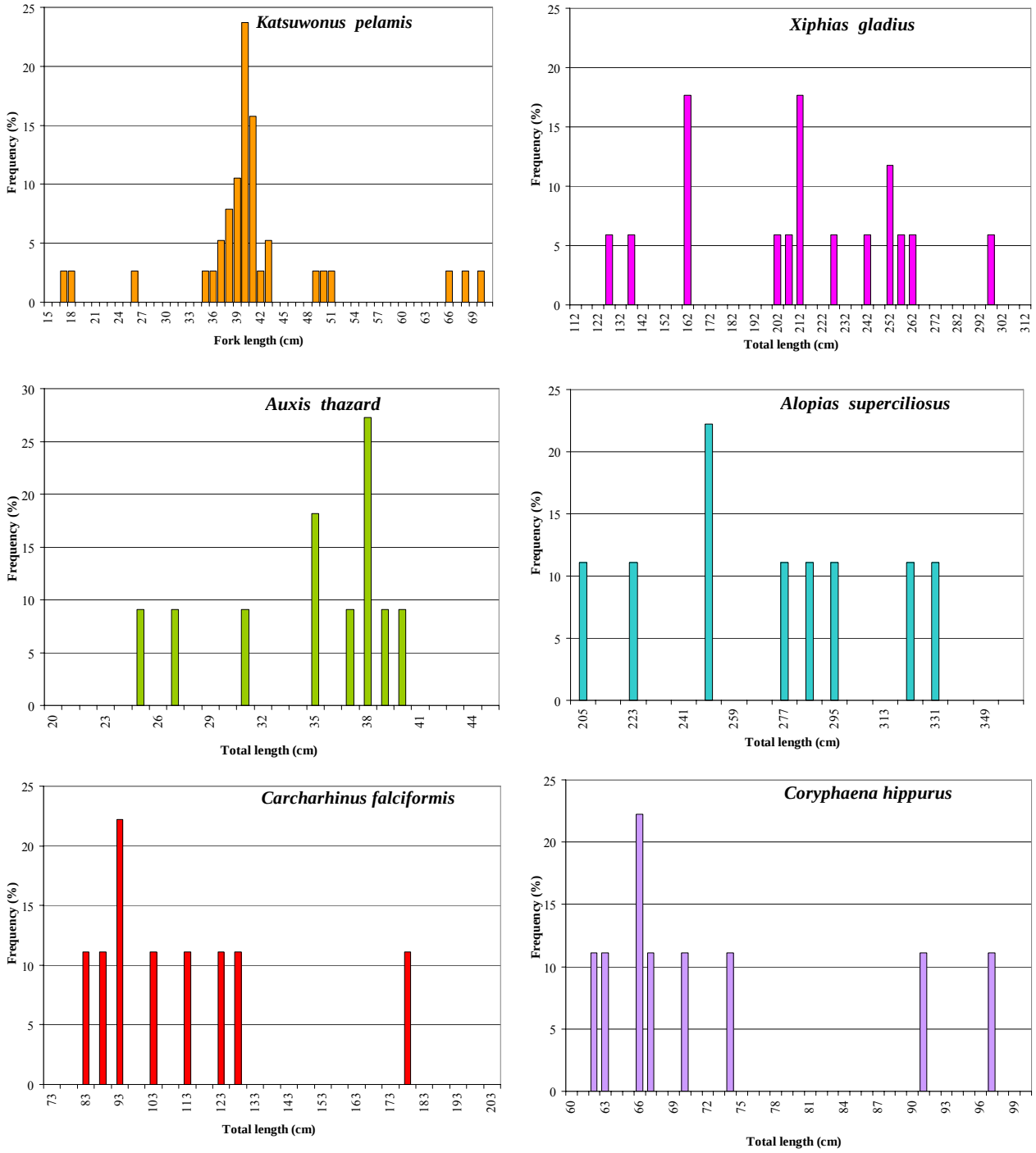

Figure 2 Length frequency distribution of six dominant species in the Bay of Bengal.

2. Length-Weight Relationship

The relationship between length and weight of *K. pelamis*, *X. gladius*, *A. thazard*, *A. superciliosus*, *C. falciformis* and *C. hippurus* showed high coefficient of correlation (r^2) which meant that weight absolutely increased with length. In addition they were allometric growth because the obtained b values were close to or bigger than 3 (Table 2 and Fig.3).

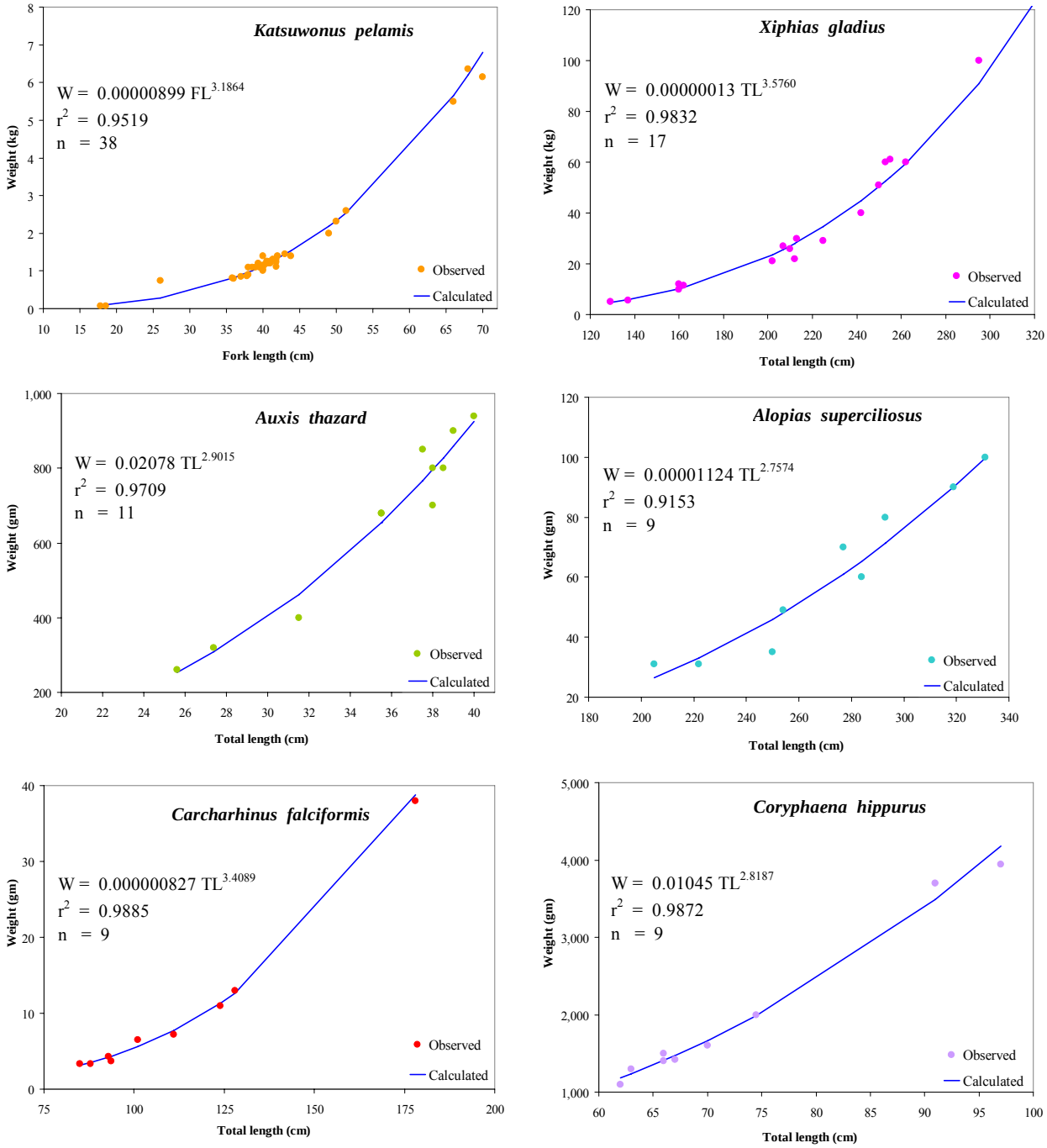

Figure 3 The relationship between length and body weight of six dominant species.

Table 2 The equations of length-weight relationship of six dominant species.

Species	n	Linear equation	Power equation	r^2
Katsuwonus pelamis	38	log W = 3.1864 log FL-5.0462	$W = 0.00000899\ FL^{3.1864}$	0.9519
Xiphias gladius	17	log W = 3.5760 log TL-6.8861	$W = 0.00000013\ TL^{3.5760}$	0.9832
Auxis thazard	11	log W = 2.9015 log TL-1.6824	$W = 0.02078\ TL^{2.9015}$	0.9709
Alopias superciliousus	9	log W = 2.7574 log TL-4.949	$W = 0.00001124\ TL^{2.7574}$	0.9153
Carcharhinus falciformis	9	log W = 3.4089 log TL-6.0825	$W = 0.000000827\ TL^{3.4089}$	0.9885
Coryphaena hippurus	9	log W = 2.8187 log TL-1.9809	$W = 0.01045\ TL^{2.8187}$	0.9872

3. Sex Ratio

The sex ratio of male and female of *K. pelamis*, *X. gladius*, *A. thazard*, *A. superciliousus* were 1:0.48, 1:0.75, 1:0.83 and 1:1.25 respectively whereas both *C. falciformis* and *C. hippurus* were 1:2. The statistic analysis showed that there was significant difference ($p<0.05$) in sex ratio of *K. pelamis* while there were no significant differences ($p>0.05$) in the others species (Table 3). In general, it could be concluded that sex ratio of male to female were mostly 1:1. Nevertheless, sex ratio also varied by environmental habitat, mortality, and nutritional status (Wenner, 1972).

Table 3 Chi-Square test of sex ratio of six dominant species in the Bay of Bengal.

Spicies	n	Male	Female	Unidentified	Sex ratio M:F	Chi-Square χ^2
Katsuwonus pelamis	38	21	10	7	1:0.48	**4.87***
Xiphias gladius	17	8	6	3	1:0.75	1.18
Auxis thazard	11	6	5	-	1:0.83	0.18
Alopias superciliosus	9	4	5	-	1:1.25	0.22
Carcharhinus falciformis	9	3	6	-	1:2.00	1.11
Coryphaena hippurus	9	3	6	-	1:2.00	1.11
Note : Chi-square from Table = 3.84, df = 1 (95% Significant)						
* significance at 95% of confident level						

4. Maturation

The result showed that the percentage of female maturation of developed, spawning and resting stages were higher than males whereas the percentage of female maturation of virgin, maturing virgin and recovering spent and developing stages were lower. There were over 50% of matured females in samples of *A. thazard* and *C. falciformis* but *C. hippurus* was found 100% of mature females. Both sexes of *A. superciliousus* were found 100% of maturation. Further both *K. pelamis* and *C. falciformis* were found 100% of immature females and males respectively (Fig. 4).

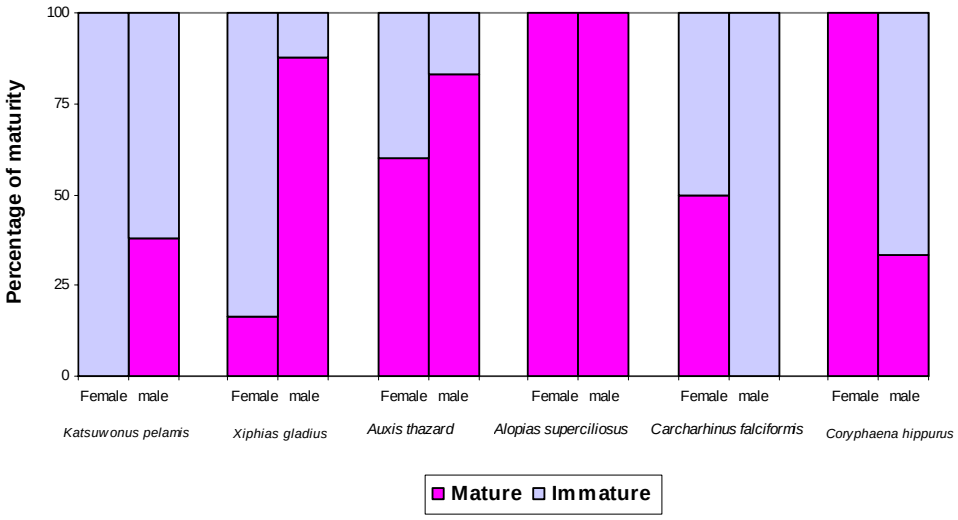

Figure 4 Percentage of mature and immature stages of the six dominant species.

It was difficult to determine spawning season in this survey because of the small number of captured fish as well as a short period to survey and absence of year round gonadosomatic index (GSI) analysis. Gonadosomatic index is one of important parameters to determine breeding cycle of fish. Sub-tropical and tropical fishes usually have an extended breeding season with females spawning many times and show changes in the amplitude of the gonadosomatic index (Wooton, 1992).

Conclusions

Generally, the average size of sampled fishes showed larger size fishes. Sex ratio of males to females were approximately 1:1. This was excluding *K. pelamis*. Although there were high percentage of mature male and female but it was difficult to indicate spawning season in this result.

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