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A study on some aspects of reproductive biology and population characteristics of *Ambligaster sirm* in the west coast of Sri Lanka

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Abstract
Ambligaster sirm is one of the important food fish resources and this is the dominant fish found in Sri Lankan coastal small pelagic fish landings. In the present study, a total of 691 Individuals of *A. sirm* obtained during the period from February to December, 2010 at the Chilaw fish landing center in the west coast of Sri Lanka, were analyzed to study the reproductive biology of *A. sirm*. Fish were dissected open and the sex and maturity stage of the gonads were determined.
Gonadosomatic Index (GSI) was used to determine the spawning season(s) Length- Weight relationships separately for males and females were also obtained. The observed average sex ratio within the study period was found to be significantly different from 1:1. The estimated length-weight relationship for males was $W=0.002685L^{3.438}$ ($R^2= 0.945$), whereas the length-weight relationship for females was $W=0.003L^{3.386}$ ($R^2= 0.940$). Maturity stages of gonads were basically divided into five categories based on macroscopic observations: virgin, developing, developed, gravid and spent. The estimated average GSI for each stage of females were 0.8593, 2.1095, 4.1606, 5.7694 and 2.7610 while the respective values for males were 0.6701, 1.3160, 3.6157, 5.5654 and 0.6552. The peaks of GSI values concluded the spawning season of *A. sirm* belongs to the period from May to July.

Keywords: Gonadosomatic Index, sex ratio, Length-weight relationship.

1. Introduction
Small pelagic fishery plays an important role in the fishing industry of Sri Lanka in terms of livelihood and nutrition. The fishery is mainly dominated by *Amblygaster sirm*; belonging to family clupeidae and order Clupeiformes. The species has a short life span of little over a year and reaches around 20 cm in length. Over 20% of contribution to the total small pelagic production depicts the importance of this food fish resource in the small scale fishery [3]. Like most other fish, unsaturated fatty acids in *A. sirm* were dominated by, the n-3 fatty acids; EPA and DHA [8].
Gillnet having the mesh size of the range from 22 mm to 38 mm is the main fishing gear used for catching *A. sirm*. In addition, a small proportion of *A. sirm* is caught with beach seines. Outboard engine Fiberglass Reinforced Plastic boats (OFRP), traditional -motorized and non motorized boats are the fishing crafts engaged in the fishery.
It has been revealed that the present level of exploitation of *A. sirm* in Sri Lanka is unsustainable. Therefore, studies on the trends of fishery and the updated biological information would be advantageous in the sense of sustainable management of the resources. The present study was undertaken to find out some biological aspects notably reproductive biology and population characteristics of *A. sirm.*

2. Materials and Methods
The study was carried out from February to December 2010 in the west coast of Sri Lanka. Freshly caught fish samples were brought to the laboratory to study the biology of *A. sirm*. Total length, Fork length and Standard length were measured up to the nearest 1 mm using standard measuring boards and body weight was weighed up to nearest 0.1 g using an electronic balance. Equations were derived for the length weight relationship.

Gonads were classified basically in to five categories: virgin, developing, developed, gravid and spent based on the macroscopic observations (*Annex i*), Weight and length of each gonad were measured and the Gonado Somatic Index (GSI) was calculated separately for males and females using following formula:

GSI = Gonads weight /Body weight*100

Spawning season was determined based on the GSI values.

Table 1: Maturity stages of *A. sirm*

Stage	State	Description
I	Virgin	Sexual organs are very small, situated close to vertebral column. Testis/ ovary translucent. Eggs not visible to naked eye.
II	Developing	Testis/ovary opaque, white or yellow with blood capillaries. Occupy about ½ to ¾ of body cavity. Eggs visible to naked eye as whitish granular material.
III	Developed	Testis reddish or creamy white, no milt produced under pressure. Ovary bright yellow or orange. Eggs clearly discernible, opaque, testis and ovary occupy about 2/3 to ¾ of body cavity.
IV	Gravid	Gonads full body cavity length. Testis white. Ovary orange-yellow, fully vascular. Drops of milt produced under pressure. Eggs completely round, some already translucent and ripe.
V	Spent	Testis/ovary occupy ½ or slightly more of body cavity. Blood shot/ flabby/limp/ flattened / gelatinous/ shriveled. A few eggs in state of respiration.

3. Results and Discussion

Variability in size has an important implication for diverse aspects of fisheries science and population dynamics [1]. One of the most commonly used analyses of fisheries data is length weight relationship [7]. Since direct weight measurements at the field is time consuming, Length-weight relationships are important in estimating weight from length [10]. Several studies have been conducted for the estimation of weight relationship of *A. sirm* in the Indian Ocean but most of them focused on unsex individuals [2]. In the present study, relationships were obtained for log transformed total length (LnL) and log transformed total weight (LnW) for males and females separately (Figure 1 and Figure 2). The b value of the length-weight relationship (the gradient of the linear regression equation) is indirectly correlated with condition factor and variation of condition factor again related to the spawning cycle [5]. In this study, both male and female showed positive allometric growth with 'b' value of 3.438 and 3.386 respectively.

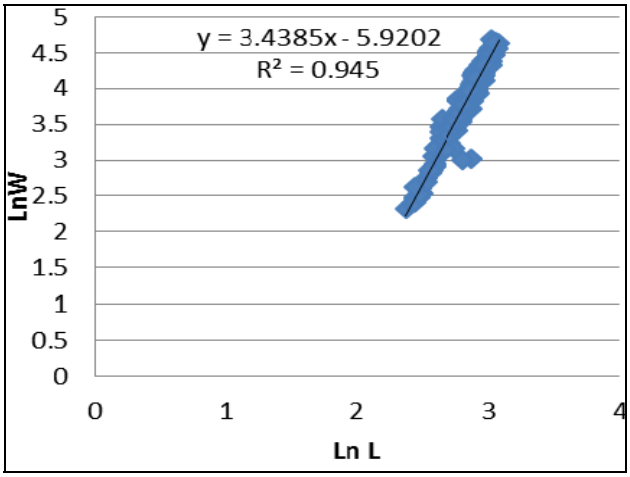

Fig 1: Length weight relationship of male *A. sirm*

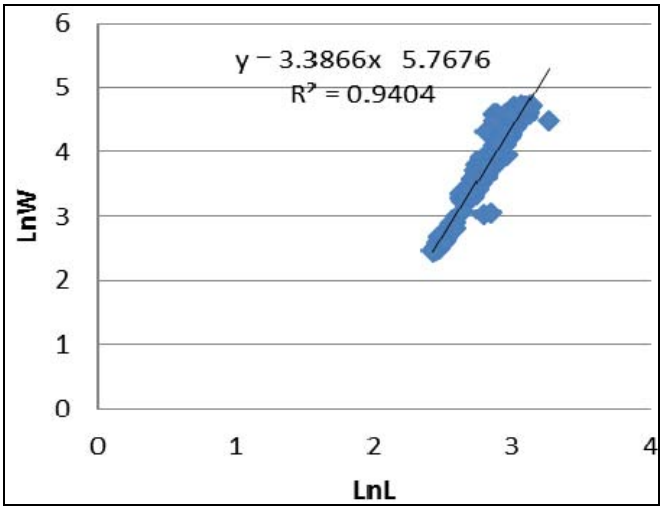

Fig 2: Length weight relationship of female *A. sirm*

Following are the length-weight relationships obtained for males and females respectively:

Male: $Y=0.002685L^{3.438}$

Female: $Y=0.003L^{3.386}$

Monthly variation of male to female ratio showed that the females dominated the natural population for many months (Figure 3). Unbalanced sex ratio in favour of females in large size groups is very common in many fish species [11]. The estimated sex ratio between male and female for the study period was 1: 1.2. This was found to be significantly different from 1:1 at the 0.01 level of significant.

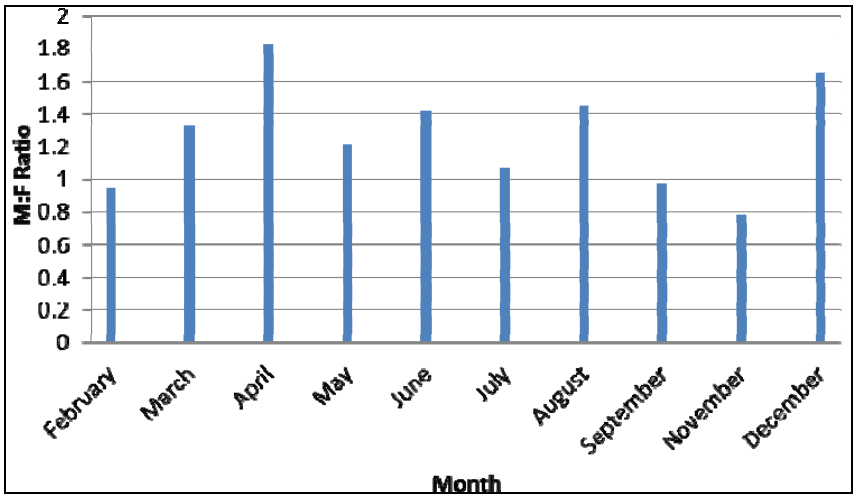

Fig 3: Average sex ratios within the study period.

The GSI values obtained in the study ranged from 0.67 to 5.56 and 0.85 to 5.7 for male and female respectively. With the sequences of maturation, it was clearly visible that the gonadosomatic index (GSI) of female *A. sirm* is always higher than the male (Figure 4). Hogg (1976) [4] also obtained similar results for the GSI of two different sexes of exotic cichlid fishes where GSI values of females were always higher than the GSI values of males because of the weight of the eggs.

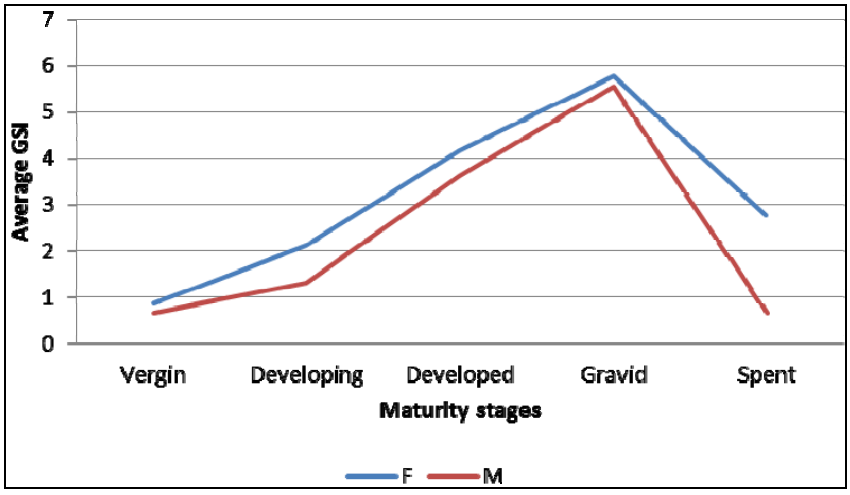

Fig 4: Average GSI values with Maturity stages

GSI is an important indicator in identifying the spawning season(s) where GSI values get increased and peaked at the spawning period. Based on the present results, spawning season of *A. sirm* in the western waters, Sri Lanka was found to be in the months of May to July (Figure 5).

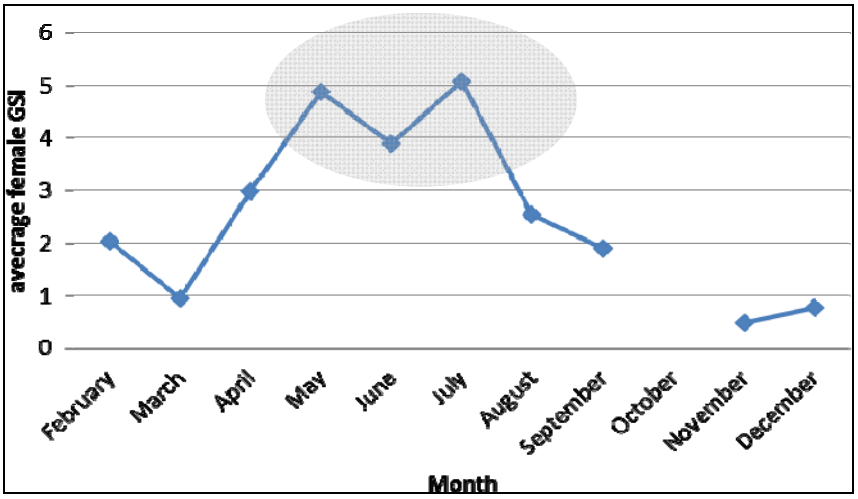

Fig 5: Average GSI values of female *A. sirm* during the study period

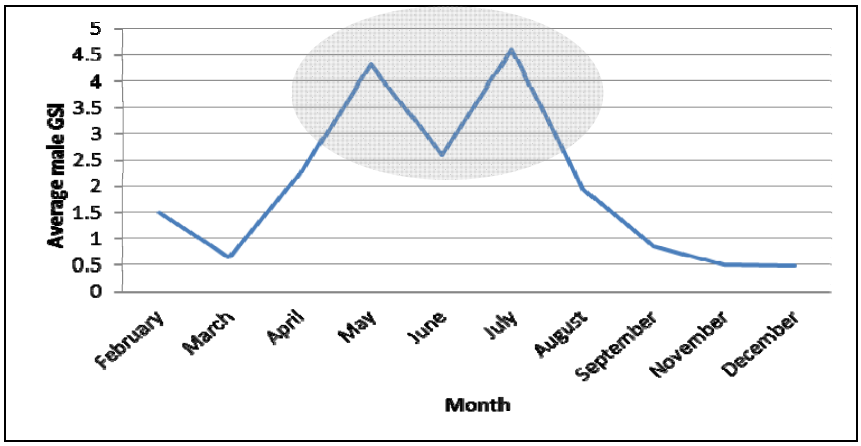

Fig 6: Average GSI values of male *A. sirm* during the study period

Variation in percentage frequencies of occurrence of female and male developmental stages are shown in the Figure 7 and Figure 8 respectively. It can be observed that gravid males and females are highly abundant during the spawning season. According to the Slotte and Fiksen (2000) [10], there is a tendency of farther migrations of herrings at their spawning season. Therefore, the above findings should be further clarified with the exact locations where fishing was conducted.

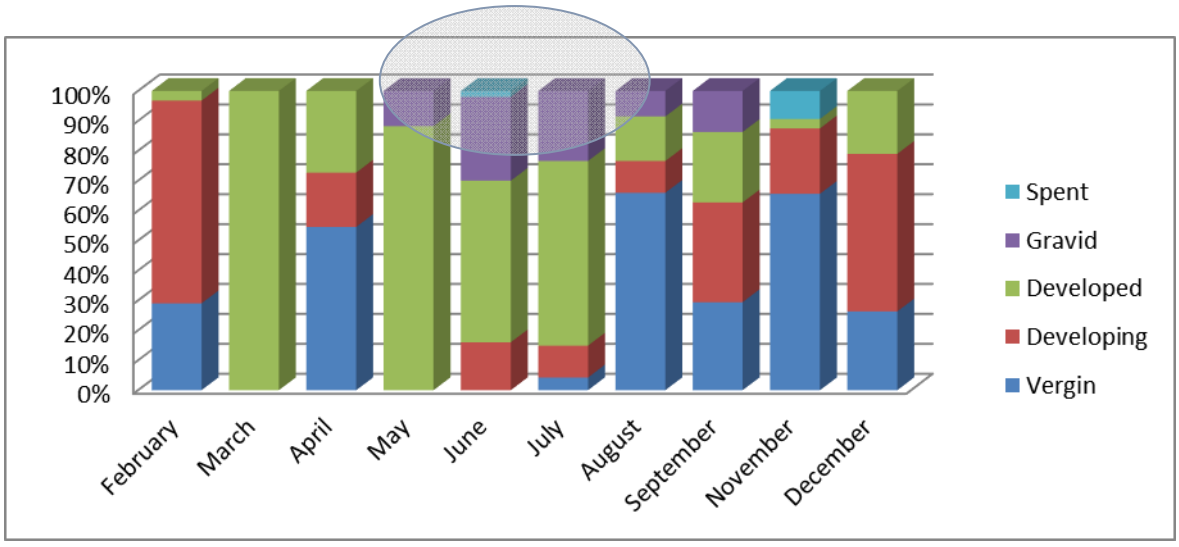

Fig 7: Monthly variation in the occurrence of female developmental stages of *A.sirm*

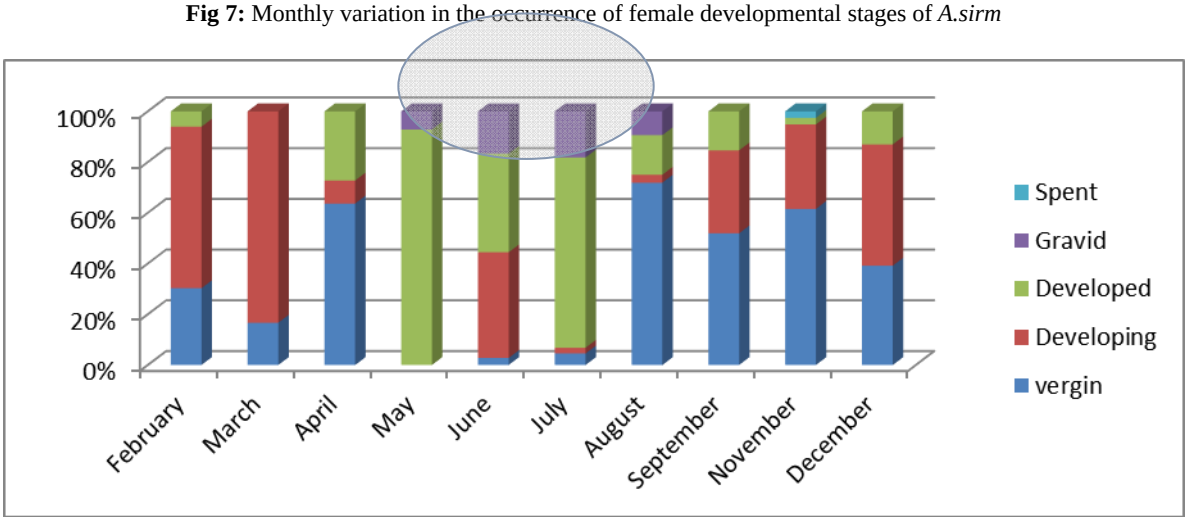

Fig 8: Monthly variation in the occurrence of male developmental stages of *A. sirm*

The above results on spawning seasons and morphometrics of *A. sirm* will be advantageous for the implementation of necessary management measures. However, further investigations should be carried out on the spawning and post spawning migrations of *A. sirm*. Hydrographic conditions during the spawning season may also affect the relative amounts of eggs and larvae drifting and thereby to the size of the stock. Therefore, further studies should channel on those aspects too.

4. Acknowledgement
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