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# Growth estimation and Length at maturity of a commercially important fish species i. e., *Dayscieaena albida* (Boroga) in Chilika Lagoon, India

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## ABSTRACT

*The growth feature of the commercially important fish species, i.e. Dayscieaena albida (locally called "Boroga"), in the Chilika Lagoon, Orissa, India, was studied. In total, 4645 of D. albida samples were collected form fish landing centers of northern sector and central sector of the lagoon and measured with their total length (TL) during the period of June 2008 to May 2009. Different cohorts were identified through multiple length frequency analysis on the total length of the species and the growth curve was estimated. The estimated growth parameters of von Bertalanffy Growth Formula (VBGF), $L_\infty$ (cm), K, and $t_0$ value were 73cm, 0.15, and -0.36 respectively. In total, 123 numbers of female samples of the species collected during April 2008 to March 2009 to investigate length at 50% maturity ($L_{50}$). For the maturity analysis, the gonads were observed by eye, according to the description by Pollard (1972) and the data were calculated in each body length class of 10-mm interval. The estimated $L_{50}$ for D. albida was 308mm (in total length).*

**Key words:** Chilika Lagoon, *Dayscieaena albida*, growth estimation, length at maturity, India.

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## INTRODUCTION

Age with growth parameters of fishes constitutes essential data to control the dynamic of ichthyologic populations. They give an important indication on the fishery resource management and on the level of their exploitation [1]. For a management regime to ensure, in the face of exploitation that a sufficient number of juveniles reach maturity usually requires information on the size and age at first maturation.

Again, surviving to sexual maturity and being able to contribute to the gene pool define fitness for an individual. Collectively, those surviving individuals determine the survival of the population. Sexual maturation has been known to be associated with physiological and

behavioral changes. The relationship between these biological changes and growth, mortality and longevity has been studied extensively [2, 3 and 4]. Using data in Fish Base, Froese and Binohlan [5] have likewise demonstrated that size and age at sexual maturity are strongly correlated with growth, maximum size and longevity.

Besides growth of a species, it is also very important to study about the reproductive cycles for better understanding and management in an ecosystem. Proper estimation of size at first maturity ($L_{50}$ - length at which 50% of the fish are mature) is very useful for fish stock management. Different methods have been proposed to estimate $L_{50}$. According to a very useful study, each individual fish should be identified as reproductive or non reproductive [6]. This recognition is usually visual and subjective descriptions of macroscopic aspects of ovaries and testes at different maturation stages have been published frequently [7]. Although a diverse methods are available for assessment of $L_{50}$, but most of the researchers apply some kind of logistic functions [8, 9, 10, 7 and 11].
*Dayscieaena albida* is an economically very important fish species for Chilika lagoon. But this species becomes gradually insufficient in the captures of the fishermen in Chilika lagoon. However, there is no growth parameters estimation for the greater number of fishes of *D. albida* in the lagoon. Therefore, to estimate the growth parameters of *D. albida* species, we have taken length data of a large number of samples from different landing center for one year of survey. This is very important to provide baseline scientific data for input policy and better sustainable exploitation of the fish stock in Chilika lagoon where an intensive overexploitation of ichthyologic resources is observed.

Although Jhingran and Natarajan [12 and 13] have studied about the body size, analysis of gonad, age of maturity and secondary sexual characters of *D. albida* in Chilika lagoon, but still the works are few, insufficient and old. The present paper will provide the information on the growth and length at 50% maturity ($L_{50}$) of commercially important fish species, i.e. *D. albida* ("Boroga" in local name) for the future management of their stocks.

## MATERIALS AND METHODS

### Study Area

Chilika Lagoon, the largest lagoon of India lies in the east coast of India, situated between latitudes 19°28' and 19°54' North and longitude 85°05' and 85°38' East. It is designated as an important Ramsar site (No.229) of India on 1$^{st}$ October 1981. The water spread area of the lagoon varies between 906 km$^2$ to 1165 km$^2$ during summer and monsoon respectively. The estuarine lagoon is a unique assemblage of marine, brackish and fresh water eco-systems. The lagoon is divided into four ecological sectors namely, the southern sector, the central sector, the northern sector and the outer channel area (Fig-4). Basically, the northern sector is fresh water dominated zone and central sector is a brackish water zone. The southern sector is a higher saline area. The outer channel is marine in nature with saline water but during monsoon, the water becomes fresh water due to discharge of flood water to the sea.

### Growth estimation

The commercially important fish species, i.e. *Dayscieaena albida*, was measured with their total length (cm) by using a measuring board at the fish landing centers of Balugaon (Central sector) and Kalupadaghat (Northern sector) of Chilika Lagoon (Fig.-4).

From June 2008 to May 2009, in total, 4645 number of fish samples was measured and the length data was recorded in the sampling format at those fish landing centers. The length

composition data of the species was used in this study.

Multiple length frequency data sets on total length of the species, aggregated into 2-cm interval by month, were analyzed in different cohorts and estimated their growth. Parameters on growth curve, occurrence rate of each cohort, and the standard deviation of length (σ) in each cohort were simultaneously estimated by maximizing the log-likelihood function composed of the multinomial statistical model after Yamakawa and Matsumiya [14]. By using this model, we analyzed multiple length frequency data sets simultaneously and obtained accurate and stable parameter values consistently. The σ was assumed to be constant irrespective of age and size of shell. No discrimination was made between males and females.

The von Bertalanffy Growth Formula (VBGF) growth equation was used in order to etermine the relationship between length and age. The VBGF was fitted to estimates of length-at-age curve using non-linear squares estimation procedures [15]. The VBGF is defined by the equation:

$$\mathbf{L_t = L_\infty [1 - e^{-k\,(t-t0)}]}$$

Where Lt = mean length at age t; $L_\infty$= asymptotic length; K = growth co-efficient, determining the rate of change in the length increment; and t = age of the *D. albida* and t0 = the hypothetical age at which the length is zero.

The asymptotic length ($L_{inf}$) of *D. albida* was fixed to 73cm, considering the largest individual observed during the study period.

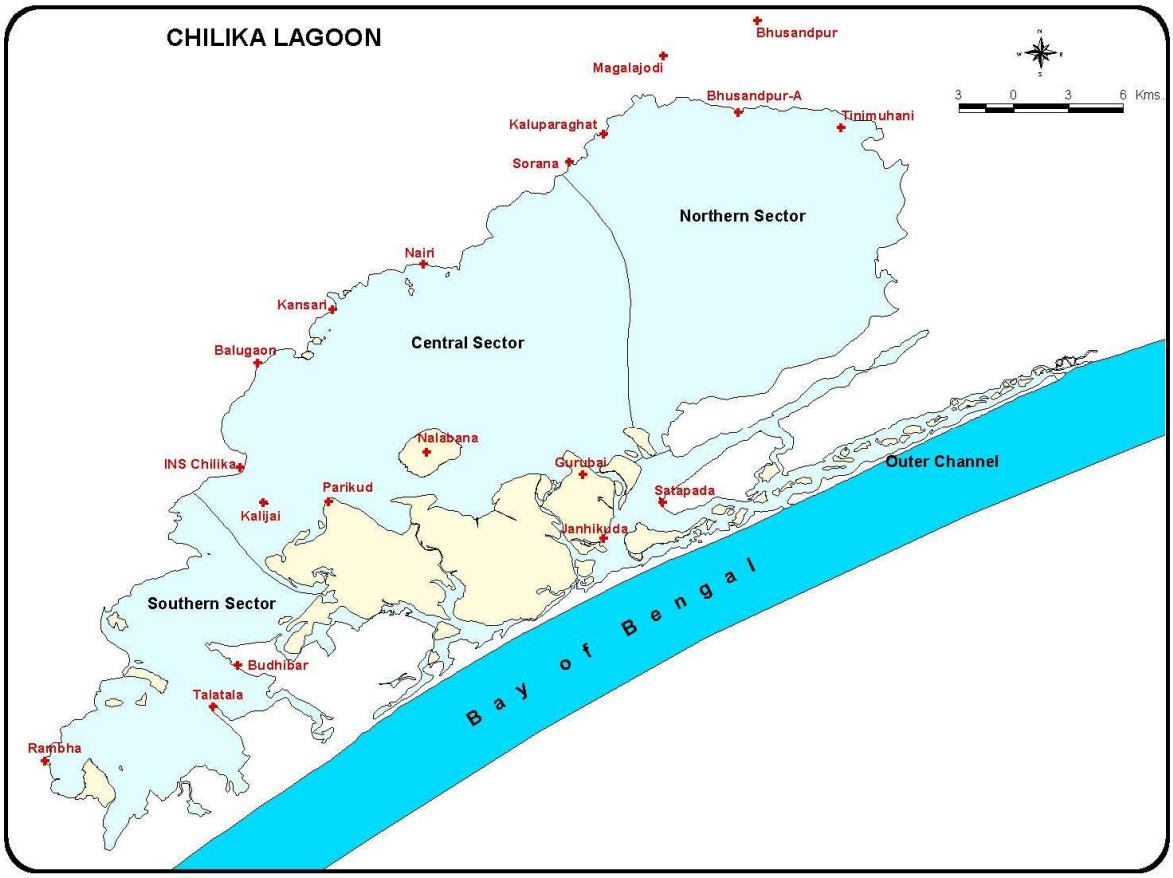


**Fig-4: Map of Chilika lagoon showing ecological sectors.**

**Length at 50% maturity ($L_{50}$)**

In total, 123 numbers of female samples of the species collected during April 2008 to March 2009 from the Lagoon and were examined. To calculate the length at 50% maturity ($L_{50}$), the proportion of mature fish, of which the gonads was observed by eye according to the description of Pollard [16], was calculated in each body length class of 10-mm interval for *D. albida*.

The $L_{50}$ was estimated by calculating coefficients *a* and *b* respectively, in the following equation of logistic curve by maximizing the likelihood of binomial distribution by using Excel add-in tool "solver" [11].

$$M(L) = 1 / (1 + \exp(-aL + b))$$

## RESULTS

**Growth**

The multiple length frequency analysis on *D. albida* detected seven cohorts (Fig. 1.1). The cohort with 20.6cm TL in June grew to 27.3cm by the next May. The estimated growth parameter of *D. albida* is shown in Table 1 and the von Bertalanffy growth equations are as follows.

$$Lt = 73.0 (1-\exp [-0.15\{t-0.39\}])$$

**Length at 50% maturity ($L_{50}$)**

Logistic equations are used to estimate $L_{50}$ because these simple mathematical functions can follow a cumulative normal curve where $L_{50}$ correspond to normal average. That is, $L_{50}$ is the average size of a species when it starts to reproduce for the first time. The parameters *a* and *b* of the logistic curves on the proportion of maturation of the females of *D. albida* was estimated as follows and those logistic curves are shown in Fig. 2.

$$M(TL) = 1/[1+\exp(aTL+b)]$$

Where, M is the maturation length, a and b are two constants.

$$M(TL) = 1/[1+\exp(-0.02633\ TL+8.1105)]$$

The estimated $L_{50}$ of *D. albida* was 308mmTL. So, at 308mm and above of total length, most of the females are identified as reproductive (maturing + spawning + post-spawning).

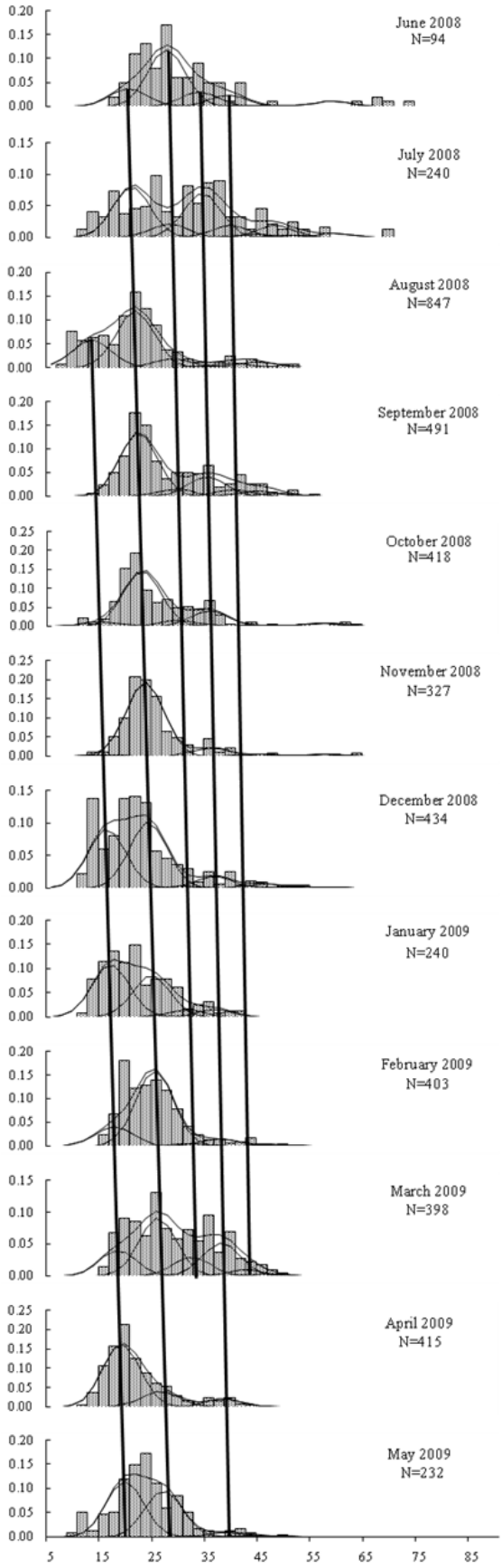


**Fig. 1: Monthly frequency distributions of total length of *D. albida* and the estimated composition of cohorts and growth curves; N = total number of fish measured in each month.**

The estimated asymptotic length (L∞) and growth co-efficient (K) of the von Bertalanffy Growth Formula (VBGF) for *D. albida* were 73.0cm and 0.15year$^{-1}$ respectively.

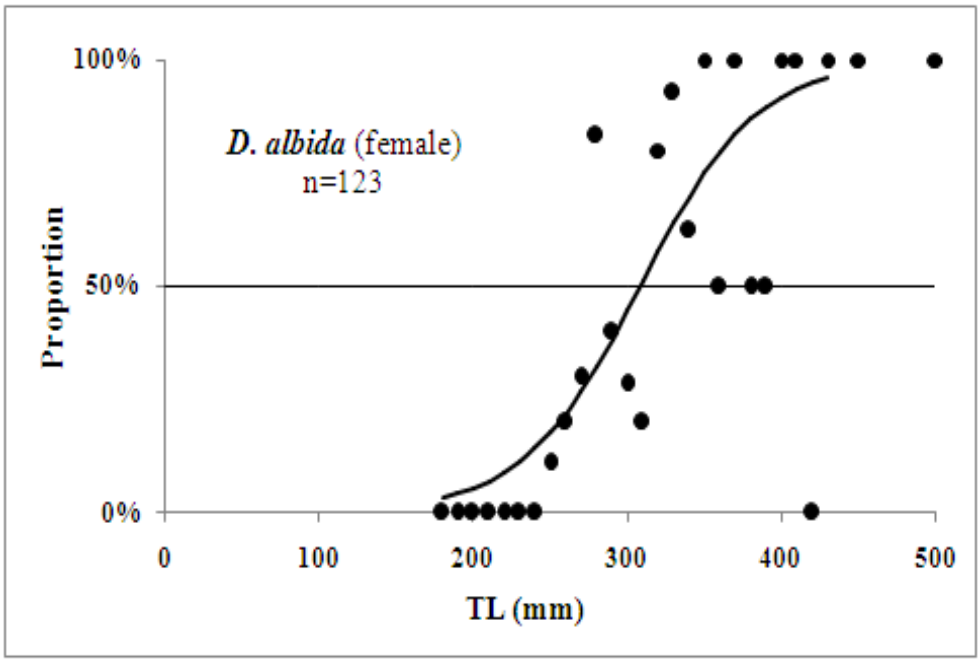


**Fig. 2 Observed (dots) and estimated (lines) proportion of mature female of varying body lengths of the females of *D. albida*; N = total number of fish observed.**

## DISCUSSION

Table-1 and 2 show the results of the studies on the growth and length (age) at maturity of *D. albida*. The L∞ and K values estimated by this study was 73cm and 0.15 respectively in which L∞ value is much smaller as compared to the results reported by Jhingran and Natarajan (1966).

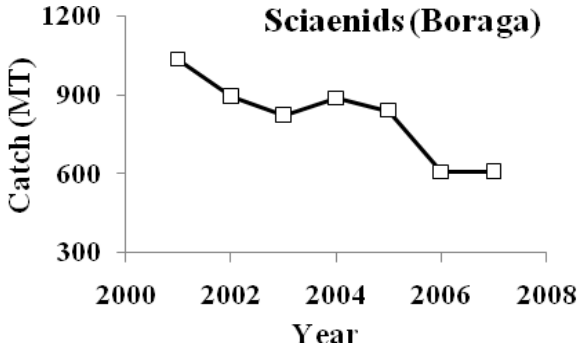


**Fig-3: Total yearly catch of Sciaenids in Chilika lagoon.**

As shown in Table 2, the minimum size at maturity of *D. albida* is reported 176mm in the male and 213mm in the female [12 and 13]. The lengths at maturity of the species studied in the present investigation is quiet larger than the studies earlier [12 and 13]. Estimated size at first maturity from $L_{50}$ investigation is 308mm (TL), whereas the minimum observed size at sexual

maturity (Gonad stages IV-VII) for female in the present study is 20 cm. Minimum weight of the matured female recorded to 76 gm only.

**Table-1: Estimated growth parameters and $L_{50}$ of *D. albida* in Chilika lagoon, India**

| Parameters | Present Study | Jhingran & Natarajan (1969) |
|---|---|---|
| L∞ (cm) | 73.0 | 168.1 |
| K (1/year) | 0.15 | 0.14 |
| t0 (year) | -0.39 | -0.07 |
| $L_{50}$ | 308mmTL | - |

**Table-2: Length and age at reaching sexual maturity**

| Lm* (cm) | Sex | Source |
|---|---|---|
| 17.6 | Male | Jhingran & Natarajan (1966 and 1969) |
| 21.3 | Female | Jhingran & Natarajan (1966 and 1969) |

**Lm: length at reaching sexual maturity*

Environmental conditions also induced phenotypic flexibility in fishes which may changing age and size at maturity [17, 18, 19 and 20]. Most studies suggest relationships among temperature, population size, and body size at maturity. Growth of a fish species is also density-dependent. Increase in population size may have led to a decrease in per-capita food availability and, thus, a decrease in the size at maturity [21]. In Chilika, total catch of Sciaenids is rapidly decreasing year by year (Fig-3). During the period of 2001-02 to 2007-08, the Sciaenids (mostly Boroga) fishery averages 814MT per year and the annual landing varies from 608MT to 1034MT. Hence, the conditions of the lagoon must changed in a great extend, which might results better conditions for food availability and ultimately fish growth. The recent increase in size at maturity of the species can be largely attributed to a phenotypic response to a complete growth rate.

The size at sexual maturity of *D. albida* is an important life history parameter that has been estimated in previous studies of sexual maturity but inadequately. The noticeable size at first maturity is often reported, however, which is not enough and very old. The current study has derived a functional relationship between the estimated proportion mature and length of the species.

## CONCLUSION

This paper provides information on the growth and the length (age) at maturity of commercially important fish species i.e., *Dayscieaena albida* in Chilika Lagoon. This information is required by most of models of stock assessment to estimate fishing mortality, population of cohorts, population of spawning stock etc. This investigation could strongly helpful to the researchers and policy makers for the preparation of very effective sustainable management plans of fishery resources of the lagoon.

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