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Age Determination of Archer Fishes (*Toxotes jaculatrix* and *Toxotes chatareus*) Inhabiting Malaysian Estuaries

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Abstract: In this study the most common bony structure (scales) and method was investigated for age determination of archer fishes. A total of 85 specimens of archer fishes (*Toxotes chatareus* and *Toxotes jaculatrix*) from the estuaries of South Johore, Malaysia were examined for age. Scale length is linearly proportion ($r = 0.816$) to standard length (SL). Relationship between scale length (L) and scale weight (W) can be expressed by the formula $W = 0.0155L^{2.917}$. Daily growth rings and annulus of scales count up demonstrated that the ages of the samples for both species were mostly 1-2 years and a handful samples of *T. jaculatrix* were above 2 years.

Key words: Archer fish, *Toxotes chatareus*, *Toxotes jaculatrix*, daily growth rings, scale

INTRODUCTION

There are seven species in the genus *Toxotes*, commonly referred to as archer fishes (Allen, 2004). According to Smith (1945), Luling (1955) and Allen (1978) they live mainly in the brackish water of mangrove-lined estuaries. These fishes are renowned for their habit of spitting water at insects and other arthropods, knocking them down to the water's surface where the shooter or another member of the school can then feed upon them (Timmermans, 2000, 2001; Timmermans and Vossen, 2000; Rossel *et al.*, 2002; Schuster *et al.*, 2004; Schuster *et al.*, 2006; Temple, 2007).

There have been few reports on the biology and ecology of this fishes (Smith, 1936; Luling, 1963; Allen, 1978; Temple, 2007; Simon and Mazlan, 2008a, b). Studies on the age and growth of fish are important for solving common problems in fishery management (Polat *et al.*, 2001). Knowledge of age structure of fish populations allows estimation of growth, mortality and recruitment and thus contributes to calculations of production rates of populations (Hilborn and Walters, 1992; Chung and Woo, 1999).

However, to the best of our knowledge there have been no studies concerning the age characteristics and method of age determination of archer fishes. Therefore,

our main aim was to determine age of these two fascinating archer fishes (*Toxotes jaculatrix*, Pallas, 1767 and *Toxotes chatareus*, Hamilton, 1822) inhabiting Malaysian estuaries. These data might help to facilitate further understanding about the biology of this intriguing fish species.

MATERIALS AND METHODS

Field sampling and laboratory preparation: Samplings of the fishes were carried out every two months in the estuaries of south Johore (Latitude 01°24'53N, Longitude 104°09'44E) Peninsular Malaysia. A total of 85 archer fishes comprising *Toxotes chatareus* and *Toxotes jaculatrix* were collected during the period from September 2006 to June 2007. Out of these specimens, a total of 21 *T. chatareus* and 33 *T. jaculatrix* individual scales were examined and yielded interpretable age estimates. The rest of the scales were rejected because they were either broken or unreadable. The sex of the fish was determined through dissection and direct observation of gonads of the samples.

Samples were collected using 3 layered trammel net, cast and scoop nets, traps as well as long lines. These gears were set up at random in appropriate places along the study areas. The mesh sizes of the trammel and cast

nets were 4.2, 6.5, 7.5 and 2 cm, respectively and of the scoop nets 1.5 cm. The length of the trammel net was 2000, 250 cm for cast net and 40 cm diameter for scoop net. Specimen identification was carried out in the field according to the description given by Allen (2004).

Standard length (SL) of the fishes was measured to the nearest centimeter. Body weight was determined to the nearest 0.01 g accuracy using an electronic balance. For each specimen about 10 scales were sampled from the central portion of the body below the lateral line according to Chung and Woo (1999) and Paul (1967). The scales were treated in 0.5% ammonia solution for at least 2 days, rinsed thrice with distilled water, dried and mounted between two microscope slides (Chung and Woo, 1999). The mounted scales were labeled, observed and photographed under a HITACHI Table Top Scanning Microscope TM-1000. The scales were weighted to the nearest 0.0001 g precision using an analytical balance A and D, Model-GR-200.

The daily increment or rings of the scale were repeatedly counted using the Adobe™ graphic software with slight modification of Mazlan and Rohaya (2008). Age of the fishes was estimated based on back-calculation of the number of daily rings (age in days) as well as the annulus (age in years) on the scale, as shown in Fig. 1a, b (Campana and Neilson, 1982; Werder and Soares, 1985). Determination of a and b values were performed by a non-linear equation and the values were obtained using Chi-square iterative goodness of fit methods with Levenberg-Marquardt and Simplex algorithms readily developed in MicroCalc. Origin™ Version 6.0 computer programme (Simon and Mazlan, 2008a). Mean while analysis of correlation (Pearson's correlation, r) between scale and fish standard length was performed using a normal linear regression analysis readily developed in similar computer programme.

RESULTS AND DISCUSSION

Scales of archer fishes are ctenoid, with 3-9 radii extending from the focus to the anterior margin. While the inner surface of the scale is smooth, the anterior and lateral fields of the outer surface are deposited with regular concentric circuli comprising individual platelets and in the posterior field circuli are replaced by rows of ctenii (Fig. 1a). Scales of two species showed clear growth zones (Fig. 1a) with each zone consisting of wide translucent band and narrow opaque band.

The rate of somatic growth is indicated or corresponded by the interspaces between circuli. Rapid growth is characterized by circuli which are relatively far

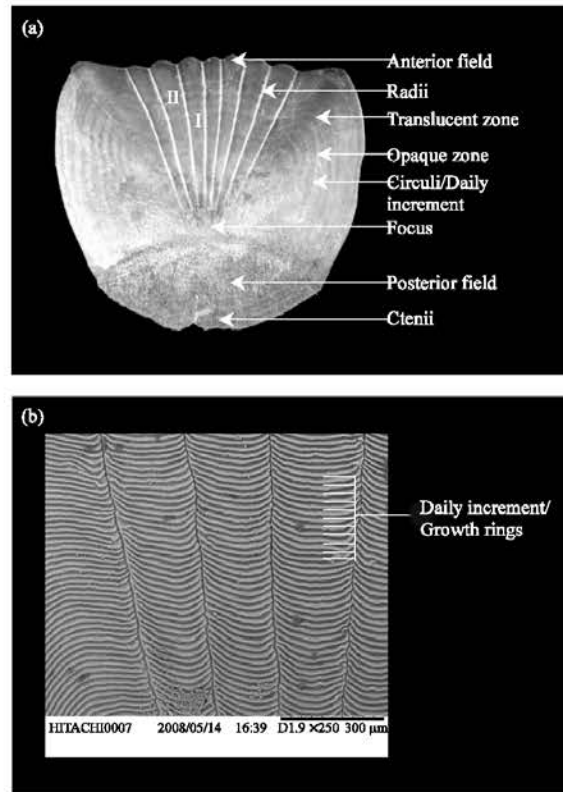


Fig. 1: Scale from an age 2+ individual archer fish (a) external morphology with annulus (I = 1st annulus, II = 2nd annulus) (b) electron micrograph showing daily increment/growth rings

apart and slow growth is characterized by closely packed circuli. An annulus is identified as the region with most densely packed circuli preceded and followed by regions of smooth transitions to regions with wide interspaces between circuli (Fig. 1a).

The length and weight of scales were highly correlated ($r^2 = 0.925$) (Fig. 2) and exponent $b = 2.917$ indicated that scale length augmented as scale weight increased. There was a linear correlation between scale length and SL ($r = 0.8166$) (Fig. 3).

A total of three age classes were identified from the 54 specimen examined. The results demonstrated for *T. jaculatrix* in the size of range 7.8-12.7 cm SL (n = 33, 9 female and 24 male) that estimated ages were from 260-733 days or less than 1 years to above 2 years, while for *T. chatareus* ranging from 6.9-12.4 cm SL (n = 21, 5 female and 16 male) the estimated ages were from 265-413 days or less than 1 years to 1-2 years respectively (Fig. 4). In the present study we observed that <1 years samples were dominated in number than 1-2 years and >2 years samples (Fig. 4).

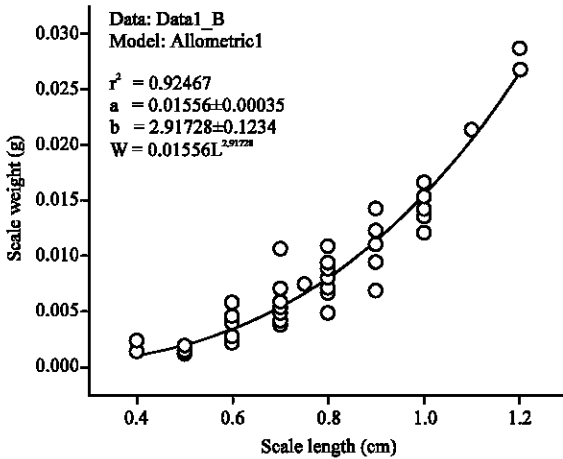


Fig. 2: Relationship of scale length and weight of archer fishes

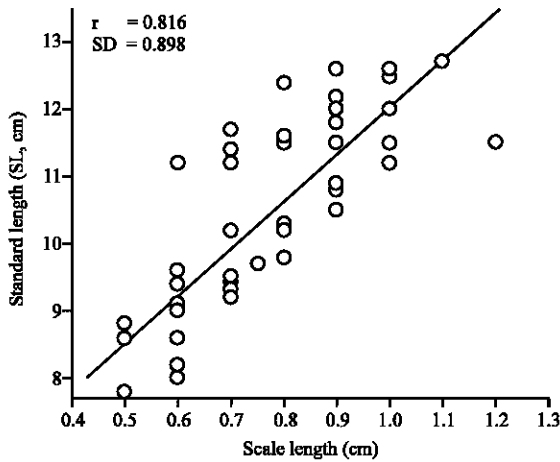


Fig. 3: Relationship between scale length and SL of archer fishes (Number of sample, n = 54)

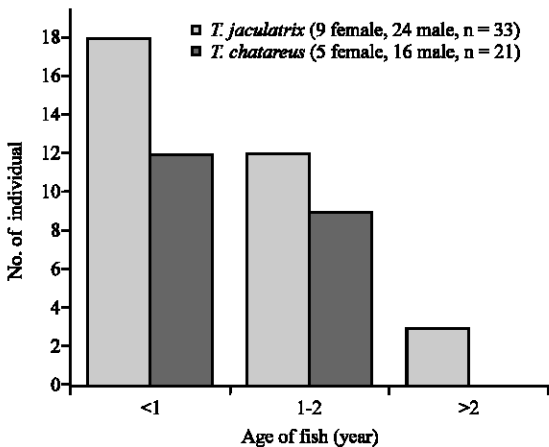


Fig. 4: Age of archer fishes (<1 = < 365 days, 1-2 = 365-730 days, >2 = >730 days)

Ageing of fishes from tropical waters has been reported through annual increments in calcified structures such as scales (Werder and Soares, 1985; Mayekiso and Hecht, 1988; Chung and Woo, 1999), dorsal and pectoral spines (Pantulu, 1961; Ezenwa and Ikusemiju, 1981), vertebral centra (Brown and Gruber, 1988) and otoliths (Fowler and Doherty, 1992). Nevertheless scales are the easiest to collect and process. Using scales as structures for ageing also avoids sacrificing the precious rare specimens like in ageing methods employing otoliths. In this study the reliability of scale readings was increased by sampling scales only from a fixed position, at the ventral side where the scales have large uniform size, better symmetry and high legibility. In other similar study elsewhere, the use of scales for aging of *Oncorhynchus clarki*, *Pomacantus imperator* and *Paraparsis colias* resulted a significant accuracy with some ambiguity depending on the fish species (Kruse *et al.*, 1997; Chung and Woo, 1999; Carbines, 2004).

Present results also in fully agreement with Chung and Woo (1999) as extremely senescent specimens were unavailable in this research; annuli readings have been relatively legible and reliable. Information on the growth of archer fishes in the Asiatic regions is still lacking, because the species is relatively scarce and specimen collection is cumbersome within a complex rooting system of mangrove forest complimented with their sharp eye vision and fast swimming speed.

In conclusion, the present study found that most of the archer fish population in the study areas comprises juvenile age group (<1 year) in comparison to sub-adult and adult age group (1-2 years). Present results also found that, the use of scales in age determination for archer fishes is more efficient likewise those reported for *Pomacantus imperato* in tropical waters. Furthermore the population of archer fish species in Malaysian estuaries is dwindling over time due to fishing pressure and habitat destruction. Therefore, the use of scales in age determination method in the present study provides a significant finding without scarifying this rare fascinating fish species.

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