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Condition Factors of Two Archerfish Species from Johor Coastal Waters, Malaysia

(Faktor Keadaan bagi Dua Spesies Ikan Sumpit dari Pesisir Pantai Johor, Malaysia)

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ABSTRACT

Archerfishes Toxotes chatareus *(Hamilton 1822) and* Toxotes jaculatrix *(Pallas 1767) inhabits mangrove estuaries, which are a critically important habitat as a spawning and nursery ground as well as the full life cycle of many fish species. In order to manage and conserve resilience fish species like the archerfish, we need to know some basic parameters about their biology and life history. Our research has focused on understanding the annual condition factors of these two species of archerfishes, as a complimentary to other several biological aspects of this two species that have been published. Our results indicated that, both species are in good conditions as the mean values of condition factors (Fulton condition factor K and Relative condition factor K_n) are greater than values of unity (K, K_n >1). The average K and K_n values of* T. chatareus *and* T. jaculatrix *were lowest in November and highest in September, indicates the spawning and recovery condition of the fishes. Condition factors measure overall fish population health that can be used by fisheries biologists and resource managers in proper management of fish resources in Malaysia waters.*

Keywords: Brackish water; conservation; growth; mangrove; Toxotidae

ABSTRAK

Ikan sumpit Toxotes chatareus *(Hamilton 1822) dan* Toxotes jaculatrix *(Pallas 1767) mendiami muara paya bakau yang merupakan habitat yang amat penting sebagai tapak peneluran dan asuhan serta kitaran hidup penuh bagi kebanyakan spesies ikan. Bagi mengurus dan memulihara spesies ikan berdaya tahan seperti ikan sumpit, kita perlu mengetahui beberapa parameter asas mengenai biologi dan sejarah hidup mereka. Penyelidikan ini telah memberi tumpuan kepada memahami faktor keadaan tahunan bagi kedua-dua spesies ikan sumpit, sebagai pelengkap kepada beberapa aspek biologi bagi dua spesies ini yang telah diterbitkan. Hasil kajian ini menunjukkan bahawa kedua-dua spesies adalah dalam keadaan yang baik seperti nilai min faktor keadaan (faktor keadaan Fulton K dan faktor keadaan Relatif K_n) adalah lebih besar daripada nilai perpaduan (K, K_n >1). Nilai purata K dan K_n bagi* T. chatareus *dan* T. jaculatrix *adalah terendah pada November manakala tertinggi pada September, yang menunjukkan keadaan peneluran dan pemulihan bagi ikan tersebut. Pengiraan faktor keadaan dalam kajian ini menerangkan keadaan kesihatan populasi ikan secara umum dari sesuatu habitat. Hasil penemuan ini boleh diguna pakai dalam penganggaran status sumber perikanan oleh ahli biologi ikan serta pengurus sumber perikanan di Malaysia.*

Kata kunci: Air payau; memulihara; paya bakau; Toksotidae; tumbesaran

INTRODUCTION

Archerfishes are the members of a family of seven species of Perciformes fish, all of the genus *Toxotes* (Allen 2001, 2004). The archerfishes are the good example of the fish species with a high degree of resiliency. Resiliency is the ability of animals to undergo, absorb and respond to change and disturbance, while changing its function. Archerfishes (*Toxotes chatareus* and *T. jaculatrix*) inhabit the interface between land and sea at low latitudes, primarily the brackish mangroves of South Pacific and Indian Oceans (Temple 2007). Mangroves occupy a harsh environment, being daily subject to tidal changes in temperature, water and salt exposure and varying degrees of anoxia. Although several researches have been conducted on the basic biology of this fascinating fishes (Simon & Mazlan 2008a, 2008b, 2010; Simon et al. 2008, 2009, 2010a, 2010b, 2011, 2012) in Malaysian coastal waters, research on their annual condition has yet to be done.

Knowledge of quantitative aspects such as condition factors, growth and length-weight relationship (LWR) of fishes is an important tool in the study of fishing biology, mainly when the species lies at the base of the higher food web (Lizama & Ambrósio 2002). The condition of a fish reflects recent physical and biological circumstances and fluctuates by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren 1951). Condition factors also give information when comparing two populations living in certain feeding, density, climate and other conditions; when determining the period of gonadal maturation and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley &

Gill 1987). As a consequence, the study of the condition factors is important for understanding the life cycle of fish species and contributes to adequate management of these species and therefore to the maintenance of equilibrium in the ecosystem.

The aim of this research was to carry out the first description on the annual condition factors (K, K_n) of two resilience archerfishes *T. chatareus* and *T. jaculatrix* collected from Johor coastal waters, Malaysia.

Materials and Methods

FISH SAMPLES

Sampling was carried out monthly in the coastal waters of Johor (01°24´ 53´N; 104° 09´44´ E), the southern part of Peninsular Malaysia from July 2008 to June 2009. Samples were collected using cast, scoop and three layered trammel nets. The mesh sizes (stretched length) of the trammel nets (three layered) were 4.2 cm, 6.5 cm and 7.5 cm and casts nets were 2 cm. Mesh size of the scoop net was 1.5 cm. The length of the nets were 20 m for trammel nets, 250 cm for the cast nets, while the scoop net diameter was 40 cm. Samples were collected at various locations throughout the study areas. Specimen identification was carried out in the field according to the description given by Allen (2001, 2004). Fish samples were immediately immersed in 10% buffered formalin and transported to the laboratory. In the laboratory, samples were given a registration number, differentiated into separate sexes. Total length (TL) was measured to the nearest 0.1 cm while total body weight (BW) was measured with an accuracy of 0.1 g (Simon et al. 2009).

CONDITION FACTORS

The Fulton condition factor (K) was calculated for each individual fish according to the equation $K = 1000\,W / L^3$ where W is the total body weight in g and L is the total length in cm (Bauchot & Bauchot 1978). The relative condition factor (K_n) was calculated according to $K_n = W / aL^3$ (Godinho 1997). The value of a and b from the length-weight relationship (Simon 2010; Simon et al. 2009), described in Table 1, were employed in calculating the relative condition factor (K_n).

STATISTICAL ANALYSIS

Analysis of variance was carried out to test the effect of monthly variation of condition factors (K, K_n). Tukey's post hoc tests were used to compare the significant differences ($p<0.05$) in mean monthly condition factors of *T. chatareus* and *T. jaculatrix*. All statistical analyses were performed using MINITAB (version 14), and Microcal Origin ™ (version 8) software.

Results and Discussion

FISH SAMPLES

A total of 350 archerfish were collected during the study. The number of *T. chatareus* captured was 145 of which 35 were females and 110 were males. *T. chatareus* males ranged in TL from 8.5 cm to 20.0 cm and BW from 12.0 to 180.2 g while females were larger ranging from 9.8 cm to 22.5 cm TL and 17.2 to 270.2 g BW. The number of *T. jaculatrix* captured was 205 of which 63 were females and 142 were males. *T. jaculatrix* males ranged in TL from 8.5 to 19.0 cm and BW from 12.0 to 142.8 g while females were again larger ranging from 8.7 cm to 23 cm TL and 13.4 to 275.0 g BW. Males of both species dominated small size-classes (8.5-15.5 cm TL) with an inversion at intermediate sizes (15.5-19.5 cm TL) and larger sizes classes (>19.5 cm TL) were made up only by females (Simon et al. 2012). The size distribution between the sexes may be the result of any or all of the following factors: males maturing earlier; a tendency for slower growth in males and (c) a higher mortality rate in males (Kartas & Quignard 1984). Another possible explanation could be spatial displacement of sexes, which has been reported in other teleosts (Cau & Manconi 1983).

CONDITION FACTORS

The mean Fulton condition factor (K) for *T. chatareus* ranged from 14.21 to 17.96 and *T. jaculatrix* ranged from 13.43 to 18.85 (Figures 1(a) & 2(a)). The relative condition factor (K_n) ranged from 0.95 to 1.79 in *T. chatareus* and 0.98 to 1.83 in *T. jaculatrix* (Figures 1(b) & 2(b)). The mean monthly K and K_n for male *T. chatareus* rose from 15.65, 1.29 in July to reach a peak of 17.37, 1.63 in September, respectively and then declined precipitously

TABLE 1. Length-weight relationship (LWR) values of two archerfish species collected from Johor coastal waters, Malaysia

Species	Sex	LWR ($W = aL^b$)			
		Sample size (*n*)	a	b	r^2
T. chatareus	Male	110	0.010	3.246	0.96
	Female	35	0.005	3.465	0.96
T. jaculatrix	Male	142	0.015	3.076	0.96
	Female	63	0.007	3.310	0.95

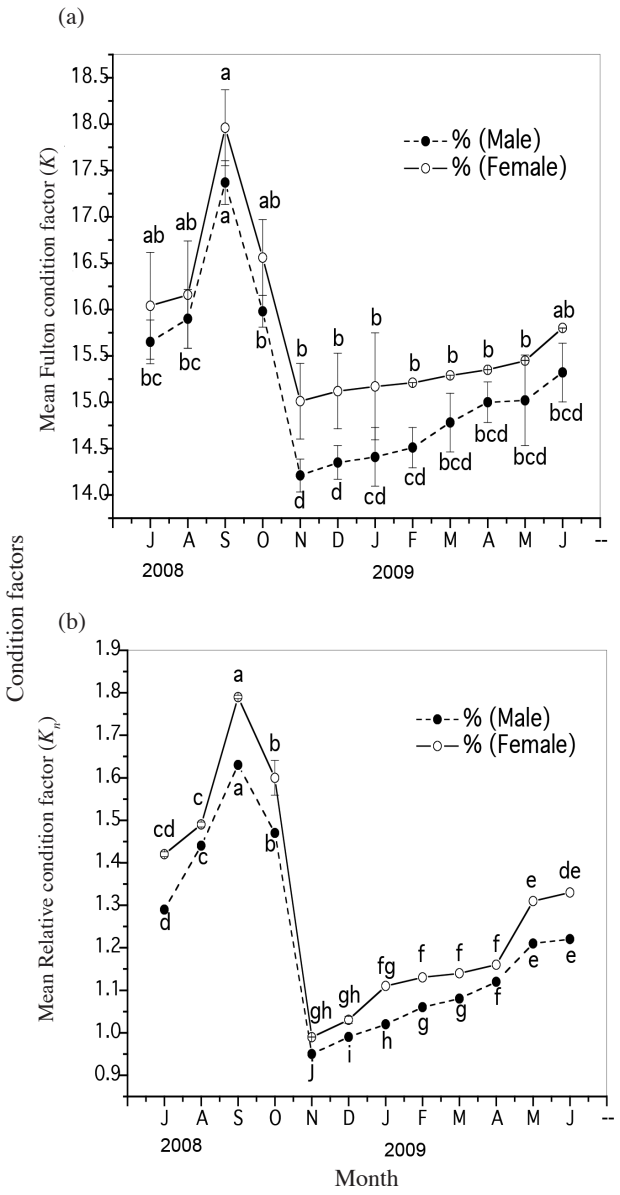

FIGURE 1. Mean monthly condition factors of *Toxotes chatareus* (a) Fulton condition factor (K) and (b) Relative condition factor (K_n). Different letters above the mean values indicate significant differences of mean condition factors at $p<0.05$

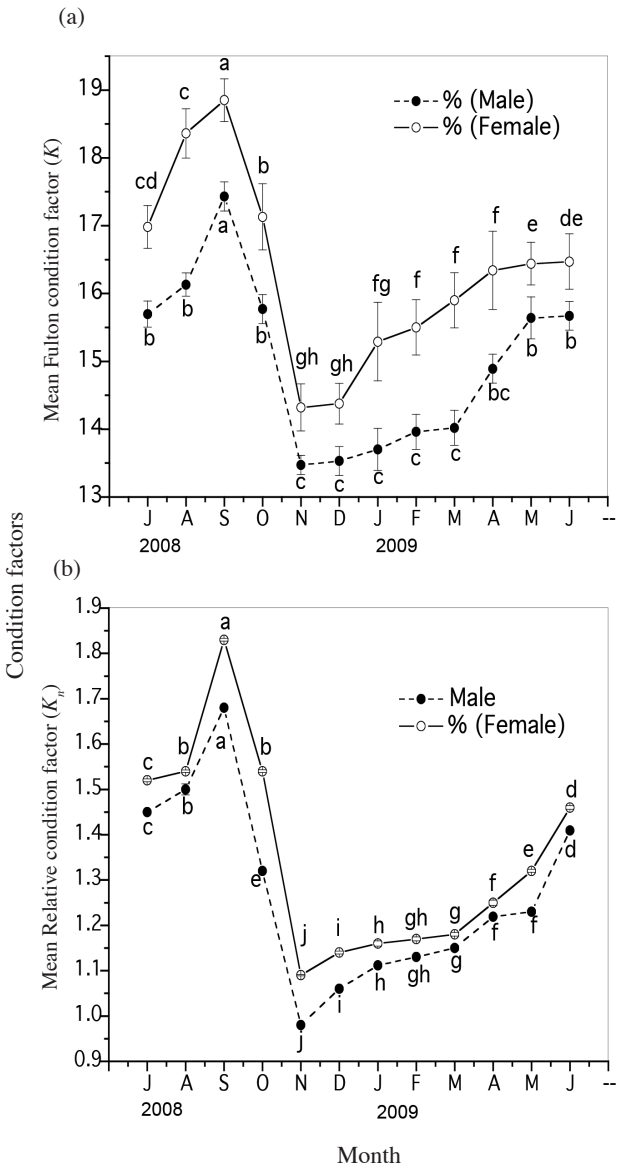

FIGURE 2. Mean monthly condition factors of *Toxotes jaculatrix* (a) Fulton condition factor (K) and (b) Relative condition factor (K_n). Different letters above the mean values indicate significant differences of mean condition factors at $p<0.05$

to 15.98, 1.47 in October and reached their lowest mean K and K_n values 14.21, 0.95 in November (Figure 1). The mean monthly K and K_n of male *T. jaculatrix* followed the similar trend rising from 15.69, 1.45 in July to a maximum of 17.43, 1.68 in September, respectively (Figure 2).

The mean monthly K and K_n of female *T. chatareus* and *T. jaculatrix* were higher than those of their males (Figures 1 & 2). The mean monthly K and K_n of female *T. chatareus* increased from 16.04, 1.42 in July to 17.96, 1.79 in September and then remained at 16.56, 1.6 in October, respectively, before declining from November to December (Figure 1). The mean monthly K and K_n of female *T. jaculatrix* showed a similar trend and increasing from 16.98, 1.52 in July to 18.85, 1.83 in September and then remained 17.13, 1.54 in October, before declining in November to December (Figure 2).

It was observed in the study that Fulton condition factor (K), for *T. chatareus* and *T. jaculatrix* were above 1 which indicates that fish in this study are in good condition. Previous study on combined sex of this species found that when K is greater than unity, the fish species is considered as in good condition (Simon & Mazlan 2008b). Bagenal and Tesch (1978) documented that for mature fresh and brackish water fish, the condition factors ought to be in the range of 2.9-4.8. The K values in the present study were relatively high for the reason that we used a more homogenous formula of condition factor $(K = 1000\ W / L^3)$ (Bouchot & Bouchot 1978). However, Safran (1992) stated

that the parameters a (condition factor) and K were judged to be less important in comparative studies, since these parameters were closely correlated with b. As a matter of fact, for applied ichthyological studies, only b seems to be important as a key parameter in estimating population growth through LWR (Kimmerer et al. 2005; Safran 1992).

The mean K and K_n of both species were lowest in November whereas highest in September for both sexes and the values were significantly different ($p<0.05$). Our previous study documented that September is the time when gonads of the most individual fish were fully grown thus contributing to the higher mean K and K_n values (Figures 1 & 2) (Simon et al. 2012). In the present study K and K_n are correlated with the changes in monthly maturity (Gonadosomatic index of fish, Simon et al. 2012). This suggests that, both species may start their reproductive period in November and recover in the following September.

The K and K_n values can be influenced by certain extrinsic factors such as changes in temperature and photoperiod (Youson et al. 1993). For the *T. chatareus* and *T. jaculatrix* in the study areas, the temperature and photoperiod elements might not be the significant factors since Malaysia has steady temperature and photoperiod changes throughout the year.

Conclusion

The present study has described for the first time the annual condition factors of two archerfishes *T. chatareus* and *T. jaculatrix*. The calculated lowest and highest condition factors in the month of November and Septermber allow us to define their spent and recovery conditions in Johor coastal waters. The information obtained from this study will be useful for fisheries biologists and resource managers in order to properly manage these fascinating fishes in Johor coastal waters and nearby areas of Malaysia.

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