Opercular Girth, Maximum Girth and Total Length Relationships for *Planiliza abu* (Heckel, 1843) and *Chondrostoma regium* (Heckel, 1843) (Actinoprerygii) from Euphrates River at Dier Ez-Zor Governorate, Syria

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Abstract: Gillnet selectivity and, therefore, capture efficiency, depends on opercular girth and maximum girth. This study examines the relationship between opercular (Gope) and maximum girths (Gmax), and total length (Lt) for two fish species sampled from the Euphrates River at Deir Ez-Zor Governorate, Syria. Data were collected between October 2009 and December 2010. Our target species were *Planiliza abu* and *Chondrostoma regium*. Gope and Gmax were found to increase linearly with total length; r^2 values ranged between 0.23 and 0.79, and were statistically significant (P < 0.01) for both species. Two groups were found (G1, G2) when the opercular girth was plotted against total length: G1 = 0.087 + 0.371Lt and G2 = 2.438 + 0.327Lt, and when maximum length was plotted against total length: G1 = 2.179 + 0.585 Lt and G2 = 2.437 + 0.378 Lt. The two groups were found to correspond to the different body shapes of fishes: G1-round and G2-slightly compressed. Our findings have implications for length data and mesh size when determining size selectivity for gill nets.

Keywords: Gill retention, Cyprinidae, Mugilidae, gill net, fisheries

Introduction

Biometric relationships, including morphometric relationships between length and weight, are used by fisheries managers to evaluate the production and biomass of a fish population (ANDERSON, GUTREUTER 1983). Morphometric relationships, such as length and girth, have also proved useful in management (STERGIOU, KARPOUZI 2003, MENDES *et al.* 2006; VIDELER 1993). As an example, NATASUME, MATSUISHI (2003) have suggested that the length-girth relationship is strongly related to fish swimming morphology, while PET *et al.* (1995) have linked length-girth relationship to fish feeding guilds.

The effect of the fish body morphology on fishing gear selectivity was firstly studied by BARANOV (1948), who described the relationship between the body shape and the mesh characteristics. Because of its influence on selectivity, it is important to consider girth in order to be able to devise better management plans (EFANOV *et al.* 1987, REIS, PAWSON 1999).

Gillnet high selectivity, high capture efficiency, and low cost of purchase and operation made this gear a preferred choice in commercial and artisanal fisheries (CLARKE, KING 1986). Gillnets are commonly used in the Tigris – Euphrates River Basin (JAWAD 2007), especially in the vicinity of Deir Ez-Zor Governorate, Syria.

Estimates of gillnet selectivity patterns may benefit from girth data, which have been demon-

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strated by several researchers (MᴄCᴏᴍʙɪᴇ, Bᴇʀsᴛ 1969, Rᴇɪs, Pᴀᴡsᴏɴ 1999, Kᴜʀᴋɪʟᴀʜᴛɪ *et al.* 2002). Estimates of retention in trawl codends may be based on maximum girth, whereas for gillnets, opercular girth is used for selectivity pattern estimation of gilled fish and maximum girth for wedged fish (Mᴄᴄᴏᴍʙɪᴇ, Bᴇʀsᴛ 1969, Mᴀʀɪᴀs 1985). Despite their importance for gear selectivity and, therefore, fisheries management, girth-based morphological data for Syrian freshwater fish are lacking. In an attempt to fill this gap, we studied the relationships between total length and both, opercular girth and maximum girth for two freshwater fish species of Syria.

Our study area comprised of the Syrian Euphrates River at the Deir Ez-Zor Governorate. The Euphrates is the longest river of Western Asia. It flows for over 700 Km through Syria before flowing into Iraq, where it joins the Tigris River and finally flows into the Arabian Sea.

We focused our study on the cyprinid *Chondrostoma regium* (Heckel, 1843) and the mugilid *Planiliza abu* (Heckel, 1843). *Chondrostoma regium* is found through the basin of the Euphrates and Tigris Rivers, as well as the Mediterranean basin of South-eastern Turkey (Esᴍᴀᴇɪʟɪ 2010) and plays an important role in the ecology of its habitat range. *Planiliza abu* is a euryhaline species that occurs in freshwaters and brackish waters of Syria, Pakistan and Iraq, mostly in the Euphrates and Tigris Rivers and in their tributaries (Kᴜʀᴜ 1979, Sᴇᴠɪᴋ, Bᴏᴢᴋᴜʀᴛ 1997). This species is economically important for food and bait (Dᴜᴍᴀɴ 2001).

Materials and Methods

Sampling was conducted mostly during the day using gillnets. Gillnets were set daily for four hours between October 2009 and December 2010 in areas ranging from 1 to 3.5 m depth. Mesh size (stretched) ranged between 25 and 75 mm. The sampled fish were stored in ice following removal from gillnets and taken to the laboratory for measurements. Total length, opercular girth (circumference of the body at operculum), and maximum girth (circumference of the highest part of the body) were measured for all specimens to the nearest 1 cm for morphological determination. We used girth instead of body height as the former represents the circumference at the selected points on the fish body which is relative to the mesh size, while the latter measures the vertical distance between the widest points on the fish body and is not related to mesh size.

Morphological relationships were estimated using ordinary least-square regression (Nᴇᴛᴛᴇʀ *et al.* 1988). Regression correlation coefficient (r^2) was used to evaluate the relationships strength.

Results

Sample size (n), minimum and maximum total lengths (in mm) for each species are presented in Table 1. The parameters *a* and *b* of the girth-length relationships, are also provided (Table 1). All linear regressions were statistically significant ($P < 0.001$). Opercular and maximum girths were plotted against total length for the two species (Figs. 1, 2).

For the relationship between opercular girth and total length, the slope *b* was lower for *P. abu* (0.327) than for *C. regium* (0.371), representing slightly greater increase in girth with length for the latter species than for *P. abu*. The correlation coefficient of the relationships was also lower in the case of *P. abu* (0.230) than for *C. regium* (0.785). These relationships indicated that the maximum and opercular girth increased faster in length for the two studied species.

Table 1. Relationship between opercular and maximum girths and total length for two fish species captured in Euphrates River, Deir Ez-Zor Governorate, Syria. Intersect and slope, a, b respectively, of fitted regression line; number of specimens, n; correlation coefficient, r2; standard error, SE

| Family/ species	*n*	Length mm		Relationship parameters				
		Minimum	Maximum	*a*	SE of *a*	*b*	SE of *b*	R²
Relationship between opercular girth and total length								
Cyprinidae								
Chondrostoma regium	48	198	321	0.087	0.673	0.371	0.029	0.785
Mugilidae								
Planiliza abu	49	132	170	2.438	1.293	0.327	0.087	0.230
Relationship between maximum girth and total length								
Cyprinidae								
Chondrostoma regium	48	198	321	-2.179	0.743	0.583	0.032	0.881
Mugilidae								
Planiliza abu	46	132	170	2.437	1.166	0.378	0.079	0.345
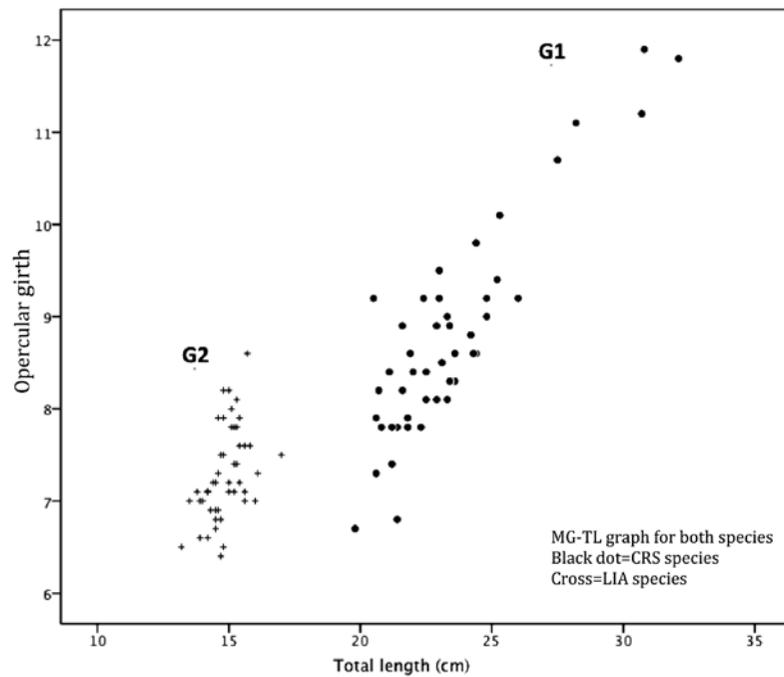
Fig. 1. Opercular girth (cm) vs total length (cm) for the two fish species studied. G1 (•): *Chondrostoma regium*; G2 (+): *Planiliza abu*
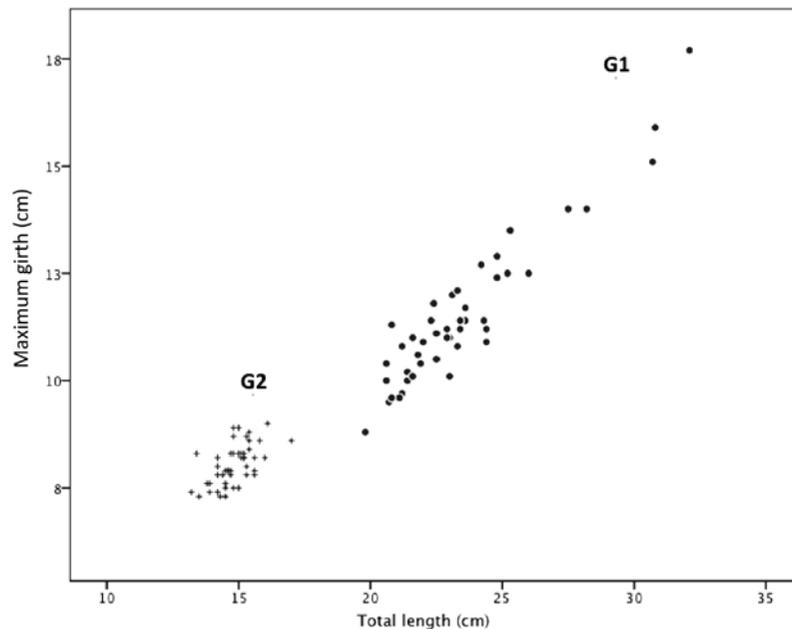

Fig. 2. Maximum girth (cm) vs total length (cm) of the two fish species studied. G1 (•): *Chondrostoma regium*; G2 (+): *Planiliza abu*

The slope *b* was lower for *P. abu* (0.378) than for *C. regium* (0.585) for the relationships between maximum girth and total length, demonstrating a greater increase in girth with length for the latter species. The correlation coefficients of the relationships were 0.345 and 0.881 for *P. abu* and *C. regium*, respectively. These relationships indicated that maximum girth increased faster with length in *C. regium*, whereas it increased slower for *P. abu*.

When plotting opercular girth of the two studied species against total length, two general groups (G1, G2; Fig. 1) were recognised. They corresponded to the girth-length relationships: G1 = 0.087 + 0.371Lt and G2 = 2.438 + 0.327Lt (Table 1). Similarly, when the maximum girth was considered, the recognised groups (Fig. 2) were: G1 = -2.179 + 0.585 Lt, G2 = 2.437 + 0.378 Lt.

Discussion

The relationships for both the opercular and maximum length to total length were found to be linear in this study. We used gillnets with a limited mesh size range, therefore, a narrow size range of fish were sampled. The application of the relations found in this study should, therefore, be limited to the size ranges used in our study. Furthermore, because of the distinctly different shapes of the species sampled in this study (*C. regium* round and *P. abu* laterally compressed), we recommend to use the parameters found only in studies where fish of the same species or fish with similar morphometric characteristics as for the species that are considered herein.

Both species assessed have shown a steeper relationship for maximum girth, rather than for opercular girth. This result is in agreement with Mendes et al. (2006) and differs from that of Jawad et al. (2009) for *P. abu*. It is also worth mentioning that there are differences in the intercepts of the relationship of both opercular and maximum girth to total length for *P. abu* obtained from Southern Iraq and that obtained for our study area. Differences in fish growth, resulting in allometry, as a function of habitat might have been the cause for such variation (Mendes et al. 2006). Similarly, specimens of *P. abu* reported by

Jawad et al. (2009) were from Shatt al-Arab River, Southern Mesopotamia, which has different ecological characteristics as compared to our study area, and thus produced fish with different morphometrical relationships. In addition, several deep bodied cyprinids were shown to have a higher slope value for the relationship of maximum and opercular girth to fish length (Jawad et al. 2009). *Chondrostoma regium* has a moderately deep body and therefore a fast increase of the maximum girth with total length, a result that agrees with the results for other deep-bodied cyprinids studied by Jawad et al. (2009).

More detailed studies are needed to answer several questions related to the influence of gillnet selectivity in catch efficiency for inland and marine Syrian waters. However, a baseline is provided for future studies on selectivity, such as its effects on catch size (Herrmann 2005), the relationship between mesh size and fish retention probability (Ingolfsson et al. 2003, Natadume, Matsuisi (2003), and the estimation of selectivity curves for a set of species with varied body shapes (Hirakawa, Shouichi 1996, Campos, Fonseca 2003).

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