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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Some morphometric features and length - weight relationships of F_1 hybrid juveniles (*Umbrina cirrosa* ♀ *X Argyrosomus regius* ♂)

F_1 juvenil hibritleri (*Umbrina cirrosa* ♀ *X Argyrosomus regius* ♂)'nin bazı morfolojik özellikleri ve boy- ağırlık ilişkileri

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Abstract: In this study, length-weight relations and some morphometric characteristics of hybrid juveniles obtained by crossing of *Umbrina cirrosa* (Linnaeus, 1758) and *Argyrosomus regius* (Asso, 1801) via artificial fertilization under aquaculture conditions were investigated. Lengths, weights and condition factors of 39 hybrid juvenile specimen varied between 26.12 and 48.67 mm, 0.7 and 0.99 g, 0.81 and 1.09 respectively. Length-weight relationship (W) was calculated (0.000009 * $TL^{3.006}$ r = 0.99). Individuals have shown isometric growth (*b*=3) according to the results of regression analyze by *b* value. All 10 morphometric measurements presented significant differences between the examined species in this study at the end of biometrical analyses except distance of maxilla and pectoral fin (MPL) (P<0.05). However, the strongest correlation was found between head length (HL) and total length (TL) (P<0.05). As a result, body height of hybrid fish was respectively lower than the parent species and length was shorter compared to Mediterranean populations indicating growth values were equal to those of natural populations

Keywords: *Length-weight relationships, morphometric characters, Umbrina cirrosa, Argyrosomus regius, hybrid*

Öz: Bu çalışmada, *Umbrina cirrosa* (Linnaeus, 1758) ve *Argyrosomus regius (*Asso, 1801)'un akuakültür şartlarında suni döllenme yoluyla çaprazlanmasıyla elde edilen hibrit bireylerinin bazı morfometrik özellikleri ve boy-ağırlık ilişkileri incelenmiştir. 39 bireyde boy, ağırlık ve kondisyon faktörü değerleri sırasıyla 26,12 - 48,67 mm, 0, 7 – 0, 99 g, 0,81- 1,09 arasındadır. Boy-ağırlık ilişkisi, 0, 000009 * $TL^{3.006}$ r = 0, 99 olarak hesaplanmıştır. Regresyon analizi sonuçlarına göre bireyler *b* değerine göre izometrik büyüme (*b*=3) göstermiştir. Biyotrik analizler sonunda örnekler arasında 10 morfometrik ölçüm içinde en önemli farklılık üst çene-pektoral yüzgeç (MPL) arasında (P<0, 05) olduğu tespit edilmiştir. Buna karşın en yüksek korelasyon baş boyu (HL) ve total boy (TL) arasındadır (P< 0,05). Sonuç olarak, hibrit balıkların vücut yüksekliği ebeveynlerinden nispeten düşük, Akdeniz populasyonlarına göre daha kısa ve büyüme değerlerinin doğal populasyonlarla eşittir.

Anahtar kelimeler: *Boy-ağırlık ilişkisi, morfometrik karakterler, Umbrina cirrosa, Argyrosomus regius, hibrit*

INTRODUCTION

The parent species of the hybrids considered in this study cannot mate in the natural environment due to the different reproduction period and behaviors and different natural habitats (Chao, 1986; Griffiths and Heemstra, 1995; Barbaro et al. 1996; Cardellini et al. 1999). On the other hand, the two closely related species in the same habitat can mate and generate hybrids when there is no any genetic barrier (Majumder and Sharma, 1997).

There are significant morphological variations between the fish species that may point out ecological and evolutionary interests and sometimes heritable (Mattson and Belk, 2013). Morphometric measurements are used to determine similarities or differences between taxonomic categories and to demonstrate ontogenetic changes of body shape in the fisheries biology area (Turan, 1999; Dwivedi and Dubey, 2013). In other words, the degree of morphologic similarities or differences between populations as well as the morpho - ecological results of the genetically rising characteristics can be defined by the morphometric studies (Chan, 2001). Morphometric measurements are widely used to identify differences between fish populations and shape-based recognition can be performed to obtain size and species information (To and Ci, 2015). According to Mattson and Belk (2013), the formation of different morphologies within same species that are specified by using of different resources can be a great power for the evaluation of new species. Recently several studies that were focused on the some hybrid culture

under aquaculture conditions. For example, Hamad (2014) reported that the significance of the morphometric characteristics of *C. gariepinus* is, due (in the Asian aquaculture) the hybrids of its with other species are cultured and detailed characteristics of the morphometric features may be needed to distinguish the different species and hybrids within the *Clarias* genus.

Also Interspecies morphologic variations are observed to be related together with the habitat, food and other factors (Moles et al. 2010). Therefore, while length-weight, length-length relations near the morphologic characteristics are useful tools to evaluate local and regional growth characters (Ricker, 1968), condition factor is the other important feature to express growth in aquaculture (Agbebi et al. 2009).

Argyrosomus regius (Asso, 1801) which is one of the 10 closely related species of *Argyrosomus* genus, is distributed across the marine and brackish waters of East Atlantic coasts, Black Sea, West African coasts (Poli et al. 2003; Sumila et al., 2007; El-Shebly et al. 2007). These species are considered as an alternative aquaculture species to gilthead sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) in the Mediterranean region, especially in France, Italy, Spain and Turkey due to their high economic value since 1990 (Garcia - Mesa et al. 2014; Gamsiz et al., 2008). Total production amount of meagre and brown meagre in the world is 43.735 tones (in aquaculture and fishing) according to FAO records in 2015. However the literature on its taxonomic status of parents of hybrid is still know and there was no knowledge about morphological characteristics of juvenile hybrids from Turkish aquaculture. Studies are carried out to reproduce more efficient species in order to close the gap in aquaculture. Hybridization studies in aquaculture aim to improve productivity via crossing available stocks of different but related species (Karahan et al. 2013). In this case, determination of the quantitative characters via molecular studies of offspring obtained by crossing two different species is becoming important (Cailliet et al. 1986). The earliest detailed studies on morphometric characters of the species belong to *Argyrosomus* genus were presented by Griffits and Heemstra (1995), and García- Mesa et al. (2014). However, there is no any study considering morphometric measurements of hybrids. The aim of this study is to investigate and fill a gap in the knowledge some of the morphometric characters such as body height, head length and weight-length relations during juvenile stage of F_1 hybrids.

MATERIALS AND METHODS

F_1 samples were taken from the larvae tanks of the hatchery (AKVATEK) where they were hatched after crossing two species (*Umbrina cirrosa* ♀ *x Argyrosomus regius* ♂) via artificial fertilization and transferred to Fish Breeding and Molecular Genetics laboratory of Ege University, Fisheries Faculty, Aquaculture Department in the sterile plates. Randomly chosen 120 day old of 39 F_1 specimen within the samples were kept in tubes containing 70% ethanol for a month in order to assess their morphometric characteristics (Figure 1) (To and Ci, 2015). In this study, potential effects of 70% alcohol preservation to 39 juvenile individuals were ignored.

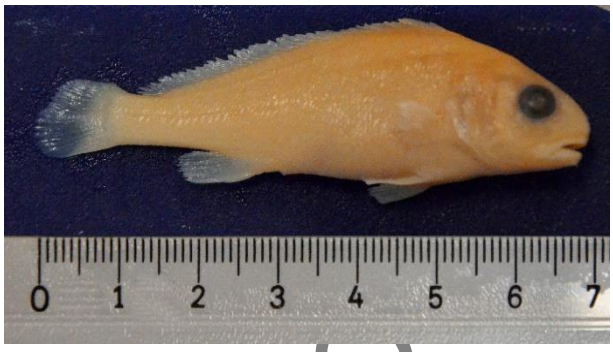

Figure 1. Sample of hybrid fish

Eleven morphometric measurements from hybrid fish were performed according to Hubbs and Lagler (1964). These measurements were 1.Total Length (TL), 2.Distance of lower jaw and anal fin (MaAL), 3.Pre-dorsal length (MDL), 4.Pre - pectoral length (MPL), 5.Pre -pelvic length (MaPL), 6.Body height (BH), 7.Head length (HL), 8.Interorbital distance (IOD), 9.Eye diameter (ED), 10.Oblic distance of second dorsal fin base and caudal fin (OD), 11. Distance of snout and eyes (MuD) respectively (Figure 2). Digital compass with 0.001 mm sensitivity was used for morphometric measurements and analytical scale with 0.0001g sensitivity was used for measuring body weight. Eight morphometric characters were evaluated as TL % and other two characters (eye diameter and distance of muso and eye) were evaluated as HL % (Carlender and Smith, 1954; Hile, 1948). Regression of various body parts against TL of the fish were drawn by least square method. Dependent and independent variables, total length and morphometric measurements, respectively, were transformed using log 10.

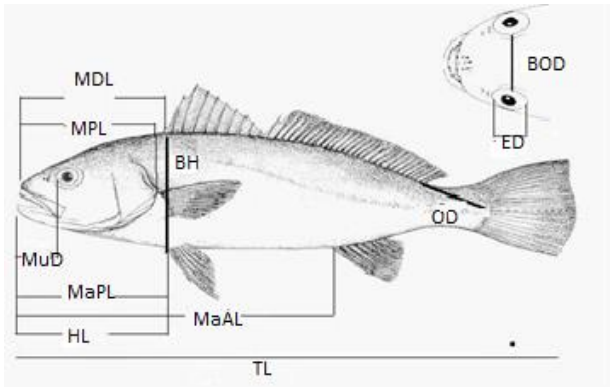

Figure 2. Diagram of morphometric characters in samples

Length- weight relation (WLR) of the hybrid samples were calculated as follows:

$W = a*L^b$ (Ricker, 1979)

W is weight (g),

L is total length (cm),

a is intersection point,

b is determination coefficient.

This formula was converted into its logarithmic expression: ln *a* + bln TL. The parameters (*a* and *b*) were calculated by least-square regression, as was the coefficient of determination (r^2). The regression co-efficient for isometric growth is '3' and values greater or lesser than '3' indicate allometric growth. Regression analysis was used to estimate confidence interval of *b* value and statistical relationships of morphometric measurements. Determination coefficient (r^2) was used to determine linear regression degree. The Fulton's condition factor values (K) of F_1 juvenile hybrids was computed following Froese (2006). Regression analysis was used to compare morphometric characters. Statistically significant differences were computed with a one-way analysis of variance (ANOVA) with P<0.05. All data were analyzed using the Statistica V4.0 software program.

RESULTS

Total lengths were found between 26.12 and 48.67 mm and weights were found between 0.70 and 0.99g of 39 juvenile hybrid fish in this study. Total length-weight relationship was W = 0.000009 * $TL^{3.006}$ (r= 0.99) (Figure 3). Morphometric parts of juvenile hybrid samples were defined proportionally as Total Length (TL) to Head Length (HL) (Table 1).

Table 1. The morphometric characteristics of F_1 hybrid samples (n = 39)

Morphometric Characters	Range	M ± SD	%	P
Total length (TL)	26.12 - 48.62	37.51 ± 7.69	100.00	P>0.05*
Distance of mandibula and anal fin (MaAL)	14.07 - 32.26	20.55 ± 4.82	54.79 TL	P> 0.05*
Distance of maxilla and dorsal fin (MDL)	3.42- 9.89	11.28 ± 2.90	30.09 TL	P> 0.05*
Distance of maxilla and pectoral fin (MPL)	7.57- 3.86	10.48 ± 1.67	27.94 TL	P<0.05
Distance of mandibula and pelvic fin (MaPL)	7.94- 5.76	11.29 ± 1.75	30.09 TL	P> 0.05*
Body heigth (BH)	6.96 -10.86	8.57 ± 0.91	22.85 TL	P> 0.05*
Head length (HL)	7.57- 4.22	10.28 ± 1.69	27.41 TL	P> 0.05*
Interorbital distance (OD)	2.12- 4.34	3.19 ± 0.61	31.03 TL	P> 0.05*
Eye diameter (ED)	0.78- 2.44	1 39 ± 0.36	13.52 HL	P> 0.05*
Oblic distance of II. Dorsal fin and caudal fin (OD)	2.02- 6.33	4.35 ± 1.18	11.59 TL	P> 0.05*
Distance of muso and eye (MuD)	1 35- 4.3	2.88 ± 0.67	28.02 HL	P> 0.05*

**: Statically differences*

As a result of the regression analysis of *b* value calculated within length-weight relationship, the samples showed isometric growth (3.006±[0.06 95 C.I. %]). Condition factor values varied between 0.81 and 1.09.

Regression analysis was used for differences between morphometric measurements. According to Table 1, significant differences were found between all measurements except between distance of maxilla and pectoral fin base (MPL) (P<0.05). Correlation coefficients of morphometric lengths-total length relationships were given in Table 2.

The closest relationship was found between total length (TL) and head length (HL) according to linear regression values (P<0.05). MaAL had the 55 % of total variation according to variation relations. Thus, an increase starting from distance of mandibular and anal fin and distance of maxilla and pelvic fin can be described. Other variation relation is IOD which constitutes 31.03 % of total variation. Therefore, the interval between head area and eyes is respectively wider.

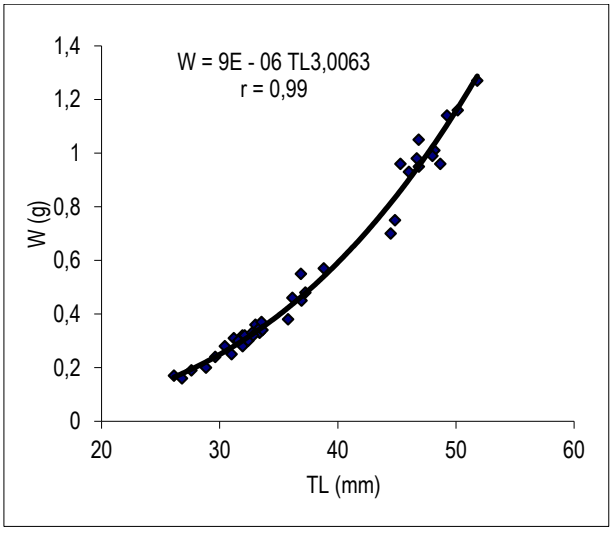

Figure 3. Total length-weight relationships of hybrid fish

Table 2. Regression relationships and transformation formulas in morphometric characters. (n= 39)

Morphometric Characters	Formulas	r^2
Distance of mandibula and anal fin (MaAL)	0.327 TL+ 0.751	0.02
Distance of maxilla and dorsal fin (MDL)	1.069TL- 0.637	0.06
Distance of maxilla and pectoral fin (MPL)	0.749 TL- 0.158	0.91
Distance of mandibula and pelvic fin (MaPL)	1.708 TL- 1.155	0.09
Body heigth (BH)	0.488 TL+ 0.166	0.85
Head length (HL)	0.756 TL- 0.177	0.92
Oblic distance of II. Dorsal fin and caudal fin (OD)	1.235 TL- 1.324	0.08
Distance of muso and eye (MuD)	1.007 TL- 0.518	0.74

DISCUSSION

There are rather various records about the maximum length size of *A. regius* in the natural populations. Some of these records are: 87 cm along France coasts, 152.5cm along England coasts and 182cm along Spain coasts (Quero and Vayne, 1987; Froese and Pauly, 2011). On the other hand, average length values of 1 year old individual in a culture environment were reported as 29.3cm, 28cm, and 27.1cm in some studies (El- Shebly et al. 2007; Rizk and Hashem, 1981; García- Mesa et al. 2014; Campoverde et al.2017). Thereby, the total length values in this study were compatible with Campoverde et al. (2017) .

b values of some species belong to *Argyrosomus* genus were given as 3.025 for *A. japonicas*, 3.055 for *A.indorus* (Griffiths and Heemstra, 1995), 2.67-3.05 (Froese and Pauly, 2011) and 2.85 (Shabana et al. 2012) for *A.regius*. *b* values (3.006) of hybrid juveniles showed an isometric growth as a result of this study. Condition factor which indicates any changes in food reserves that were stocked in the fish muscle is another important fact. The high mean condition values in the aquaculture environments presented by García - Mesa et al. (2014), El-Shebly et al. (2007) and Poli et al. (2003) are promoting our study results as well. Although one of the main reasons for the condition factor changes is known to be gonadal development and increasing metabolic activities, the possible effects of the food composition that juveniles were fed, feeding interval, water temperature and number of the samples in the various results of condition must be kept in mind (Tesch 1971; Wotton 1992). The results of condition coefficient values suggest crossing of these two species in commercial scale strongly.

Total Length (TL) and Head Length (HL) values are considerable morphometric measurements showing a strong relationship and there are significant variations between these characteristics in our study ($P< 0.05$). The results of pre-anal, pre-dorsal, pre-pelvic, pre-pectoral, body height, head length and pre-orbital length measurements of the individuals were compared to those of Froese and Pauly (2011). Thus, all measurements except pre-anal distance of the individuals were higher in this study. These results indicate that hybrid individuals that obtained from Mediterranean originated breeders (*A. regius* and *S. umbra*) may carry morphometric features of Mediterranean Sciaenid populations (Shabana et al. 2012). Indeed, a molecular investigation of the considered hybrid offspring showed 100 % of the individuals exhibited a genotypic signature combining specific alleles from each species (Karahan et al. 2014). Our morphometric measurements that were demonstrated in this study was a clear evidence of the hybrids' acquire of mix characteristics that came from both parent species (Majumder and Sharma, 1997). Mattson and Belk, (2013) presented different morphometric variations resulting from using different niches depending on the different resources in benthic and pelagic locations for *A. inodorus* which is a bento-pelagic species. Yet, gen flow is not an expected factor or is low effective for interspecies morphological variations for marine fish compared to fresh water fish (Mattson and Belk, 2013). In this case, morphologic variations between marine fish require more investigations.

As conclusion, hybrid individuals have reached even growth speed of the natural populations (Hudson, 1989), despite of having shorter length. The variations of morphometric characteristics obtained in this study present valuable findings in the terms of referring morphometric changes of populations. But preservation in alcohol effect must be considered in the size lengths (Jawad 2003). Both hybrids of *A. regius* and *S. umbra* in the close future are likely to be cultured all over the world.

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