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Morphological variability of *Liza aurata* (Risso, 1810), along the southern Caspian Sea

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KEYWORDS

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Mugilidae

Abstract Morphological variability of *Liza aurata* (Risso, 1810), was studied in traditional morphometric measurements in 25 morphological characters from 90 specimens in three fishery areas in the southern Caspian Sea (Guilan, Mazandaran and Golestan). Univariate analysis of variance showed significant differences between the means of the three groups for 22 out of 25 standardized morphometric measurements. In discriminant function analysis (DFA), the proportion of individuals correctly classified into their original groups was 100%. Principal component analysis results (PCA) for morphometric data indicated that samples of Guilan and Mazandaran showed high degree of overlap and these two regions were highly different from Golestan. The dendrogram derived from cluster analysis showed that the samples of *L. aurata* from Guilan and Mazandaran had same clade while both were obviously distinct from Golestan.

Introduction

The golden grey mullet, *Liza aurata* is a mugilidae species in which adults are neritic usually in schools, entering lagoons and lower estuaries (Thomson, 1990). Golden grey mullet habitats in eastern Atlantic, Mediterranean and Black Sea during the years 1930–1934, scientists from the former Soviet Union introduced different mullet species, including the golden mullet (*L. aurata*), from the Black Sea to the Caspian Sea. The introduction of *L. aurata* was successful, and it is currently of high economic importance (Ghelichi et al., 2004; Thomson, 1997; Zenkevich, 1956). In the catch composition in the southern Caspian Sea, the golden grey mullet, *L. aurata*, predominated in the years 1995–2009, accounting for 76–98% of the catch (Fazli, 2011). Golden grey mullet in the Caspian Sea spends spring in the north and autumn in the south (Probatov and Tereshchenko, 1951). They feed on small benthic organisms, detritus, and occasionally on insects and plankton (Ben-Tuvia, 1986). *L. aurata* is one of threatened species with least concern which is in red list (IUCN, 2012). Study of fishes in aquatic ecosystem is important from point of evolution, ecology, behaviour, conservation, water resource management

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and stock assessment (Anvarifar et al., 2011). Suitable management success of aquatic animal stock will be gained by study of genetic stock of endemic species, and identification of populations (Coad, 1980). To rational and effective fishery management, determination of exploitive fish stock is too important, because each stock needs separate management to aim of optimal harvest (Erguden and Turan, 2005; Salini et al., 2004). The study of morphological characters with the aim of defining or characterizing fish stock units has for some time been a strong interest in ichthyology (Tudela, 1999). Golden grey mullet has been broadly studied, in terms of biological characteristics (Fazli, 1998), age and growth (Andaloro, 1983; Fazli et al., 2008; Ilkyaz et al., 2006; Kraljevic et al., 2011; Mehanna, 2006), reproduction (Ghaninejad et al., 2010; Hotos et al., 2000), systematic status (Turan et al. 2011), distribution and migration (Mickovic et al., 2010), genetic diversity (Ghodsi et al., 2011), and phylogenetic relationships (Turan et al., 2005). However, information on population differentiation of adult specimens in the Southeastern Caspian Sea is still rather limited (Kohestan-Eskandari et al., 2013). In addition, it is important to understand that this unit population has morphological differentiation. The aim of the present study was to examine the morphological variation of *L. aurata* in the southern Caspian Sea basin to evaluate the differences between golden grey mullet community runs to be employed in the future enhancement programs to maintain this valuable species in the sea.

Material and method

Sampling

A total of 90 adult individuals of *L. aurata* were collected from three northern provinces of Iran in February 2014, that comprising 30 individuals from Guilan (37°29′N, 49°26′E), 30 individuals from Mazandaran (36°36′N, 52°10′E) and 30 individuals from Golestan (36°56′N, 53°59′E) (Fig. 1). The specimens were caught by beach seine and preserved in 4% formalin and sent to the marine biology laboratory of Khorramshahr University of Marine Science and Technology.

Laboratory work

25 traditional morphometric characters were measured in centimetres using a digital caliper to the nearest 0.01 mm (Fig. 2); measurements followed Ibanez-Aguirre et al. (2006), Kastelis et al. (2006), Konan et al. (2014) and Rezaei et al. (2012). To avoid human error all morphological measurements were performed by the same person. After measuring, fish was dissected to identify the sex by macroscopic examination of the gonads. Gender was used as the class variable in ANOVA to test for the significant differences in the morphometric characters if any, between males and females of *L. aurata*.

Data analysis

As variation should be attributable to body shape differences, and not related to the relative size of the fish, an allometric method (Elliott et al., 1995) was used to remove size-dependent variation in morphological characters:

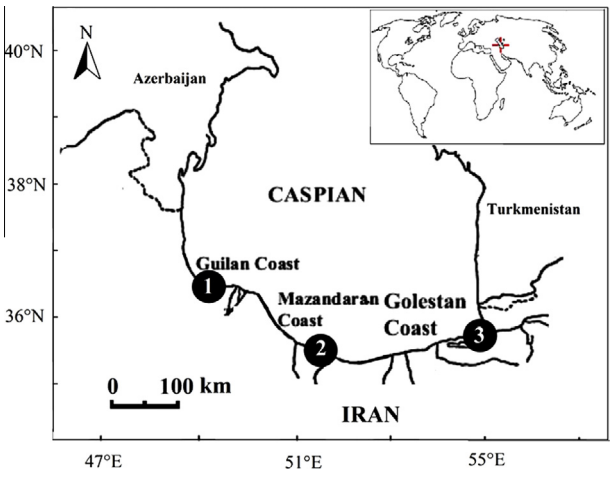

Figure 1 Map of the southern Caspian Sea showing the location of fishing regions (1– Guilan, 2 – Mazandaran and 3 – Golestan) for *Liza aurata* (Risso, 1810).

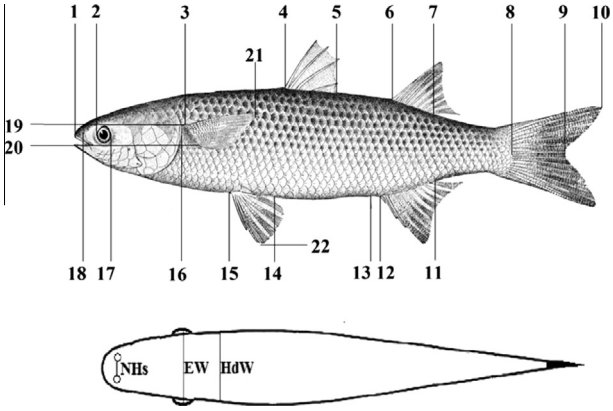

Figure 2 Codes of morphological characters investigated in *Liza aurata* (Risso, 1810), along the southern Caspian Sea.

$$M_{adj} = M(L_s/L_0)^b$$

where M is original measurement, M_{adj} is the size adjusted measurement, L_0 is the standard length of the fish, L_s the overall mean of standard length for all fish from all samples in each analysis, and b was estimated for each character from the observed data as the slope of the regression of $\log M$ on $\log L_0$ using all fishes in any group. The results derived from the allometric method were confirmed by testing the significance of the correlation between transformed variables and standard length. Univariate analysis of variance (ANOVA) was performed for each morphometric character to evaluate the significant difference between the three locations (Zar, 1984) and the morphometric characters that were significant were used for function analyses (DFA) and principal component analysis (PCA). As a complement to discriminant analysis, morphometric distances between the individuals of three groups were inferred to cluster analysis (CA) (Veasey et al., 2001). Statistical analyses were performed using the SPSS version 21 software package and Excel 2007.