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Distribution and morphological variation of *Emys orbicularis* in the coastal areas of the Caspian sea

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The coastal areas of the Caspian Sea are geographically unique and provide habitats for different flora and fauna. One of the remarkable inhabitants of this area is the European pond turtle, *Emys orbicularis* (Linnaeus, 1758), about which very little is known. In our study thirty seven (37) adult males of *E. orbicularis* have been identified in the Golestan, Mazandaran, Ardebil, and East Azerbaijan Provinces of Iran and it appears they are morphologically similar and belong to the same group. However, the turtles of Golestan Province have the smallest size shell of the studied groups. This variation, compared to other studied populations, may be explained by the differences in habitat and geographical location.

Key words: *Emys orbicularis*, morphology, Caspian Sea, Iran

INTRODUCTION

The European pond turtle, *Emys orbicularis* (Linnaeus, 1758) is widely distributed in North Africa, Southern, Central and Eastern Europe, Central Asia, and the Middle East up to the Caspian Sea and Aral Sea (Hojjati et al., 2003, 2007; Kami et al., 2006; Fritz et al., 2004, 2005, 2008). The Iranian populations of *E. orbicularis* occur in the southern part of its distribution range. Since Iran is mostly uninhabitable for pond turtles, their populations are restricted to the coastal drainage area of the Caspian Sea, and they are found only along the coastal areas of the sea in Golestan, Mazandaran, Gilan, and Ardebil provinces of Iran (Kami et al., 2006; Hojjati et al., 2007). This species is also distributed in the northern adjacent countries of Transcaucasia (Anderson 1972, 1974; Fritz et al., 2007; Arakelyan and Parham, 2008).

Studies of Iranian amphibians and reptiles are in progress and have increased over the last few decades. However, the reported literature about Iranian turtles is sparse (Hojjati et al., 2003, 2007; Kami et al., 2006; Fritz et al., 2007; Rastegar-Pouyani et al., 2008). Hojjati et al. (2003, 2007) and Kami et al. (2006) are the prime sources of information about the morphological characteristics, and also some ecological notes on *Emys* in Golestan and Mazandaran provinces. Fritz et al. (2007) added the molecular data of mtDNA lineages for the European pond turtles in Iran. Fritz et al. (2007) compared different populations based on the mtDNA, but the reported results did not support the morphological diversity of the turtles. According to the literature, *E. orbicularis* from the coastal areas of the Caspian Sea belongs to *Emys orbicularis persica* (Kami et al., 2006, Fritz et al., 2007, Rastegar-Pouyani et al., 2008, Rhodin et al., 2010), whereas, the synonym of this subspecies is *E. o. orientalis* (Fritz, 1994).

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The eastern pond turtle is found in a wide variety of habitats, including ponds, lakes, streams, rivers and drainage canals, some of which may completely dry up during the summer months. The population of this taxon in many parts of the distribution areas are in fact in severe decline due to the loss of habitat combined with population fragmentation (Anton et al., 2008). In Iran the destruction of habitat, pollution, and fishery interactions (intentional killing) are the main threats to the survival of this species (Ghafarri et al., 2008). In this study we looked at comparative morphological and ecological analysis among the specimens of *E. orbicularis* collected along coastal areas of the Caspian Sea.

MATERIAL AND METHODS

SPECIMENS

The field work was undertaken from April 2008 to April 2010. During this period of time, we handpicked 40 adult samples (37 males and 3 females) of *E. orbicularis*, from swamp and wetlands in 4 provinces along the coastal areas of the southern Caspian Sea (Fig. 1). Of these, 10 were collected from Mazandaran, 8 from Golestan, 9 from Ardebil and 10 from East Azerbaijan provinces respectively. Morphological analysis was performed on the adult males.

FIGURE 1. Map of the sampling sites in coastal areas of the southern Caspian Sea, Iran.

The following morphological characteristics were measured by callipering all sampled specimens (with an accuracy of approximately 0.02 mm): Carapace length (CL), Plastron length (PL), Carapace width (Median) (CW), Maximum carapace width (MCW), Shell height (SH), Length of bridge (LB), Gular suture length (GSL), Humeral suture length (HSL), Pectoral suture length (PSL), Abdominal suture length (AbSL), Femoral suture length (FSL), Anal suture length (ASL), Nuchal scute length (NL), Nuchal scute width (NW), Vertebral length-first (VL1), Vertebral length-second (VL2), Vertebral length-third (VL3), Vertebral length-fourth (VL4), Vertebral length-fifth (VL5), Inner height of anterior shell opening (IHASO), Inner height of posterior shell opening (IHPSO). All turtles were photographed and then released.

STUDY SITES

Golestan and Mazandaran provinces are located south and southeast of the Caspian Sea, while Ardebil and East Azerbaijan provinces are west and southwest of the Caspian Sea. The Elburz Mountains begin from in Ardebil area and continue through the southern part of the Caspian Sea. The Elburz Mountains therefore geographically separate the Mazandaran and Golestan populations from East Azerbaijan and Ardebil populations.

Golestan Province: The Aq Qala wetland is situated in south of the Atrak River, near the Turkmenistan border, approximately 59 km to the east of the Caspian Sea. The studied site (37° 20' N, 54° 35' E; 189 m above sea level) was in the Almagol and Alagol wetlands, which are part of the Aq Qala wetland system. The water of the wetlands is brackish, as it is a branch of the equally brackish Atrak River. The climate of this area is warm Mediterranean, with semi tropical plain and posture appearance.

Mazandaran Province: The sampling sites are close to Behshahr City and the Miankale wetland (36° 48' N, 53° 33' E; 0 m above sea level), located approximately 8 km south of the Caspian Sea. The area is situated in semi-tropical coastal plain with meadow, green and lush in appearance with mild and wet weather. The water of these wetlands is slightly brackish.

Ardebil Province: Specimens were collected from east of Ardebil City (38° 13'N, 48° 46' E; 707 m above sea level), located 9 km to the Caspian Sea. This area is covered with steppe vegetation, and shrubby plain. In comparison with the other sites studied, this area has some mountains. The water in the lagoon area is similar to the Mazandaran wetland and is slightly brackish. The gentle breezes coming off the Caspian Sea have some influence on the climate of the lowland areas.

East Azerbaijan Province: The rich region of the Arasbaran forest occurs in the northern parts of this province, which is 44 kilometers away from the Aras River, and also 110 kilometers east of the Caspian Sea (38° 59' N,47° 31' E 442 M above sea level). The study area in this province has a cold and semi-arid climatic condition, and is mostly covered by forests.

STATISTICAL ANALYSES

Morphological characters were summarized as mean, standard deviation (SD) and standard error of the mean (SE). The morphometrical variation was analysed using two-way ANOVA. We conducted Principle Component Analysis (PCA) by using only raw characters of males. We used two-way ANOVA to evaluate the main effects of localities and number of rings of carapace for measurements of body size, simultaneously. Significance levels for all tests were set at $P<0.05$. Statistical analyses were performed using the SPSS 11.5 and STATISTICA 7.0 software.

RESULTS

The size parameters of turtles were CL, PL, CW, and CH from the 4 populations did not show significant differences between localities and the number of rings on carapace according to two-way ANOVA (Wilks $\lambda=0.35$, $F(20, 70.599)=1.33$, $p=0.19$). However, our study showed that the males in Golestan province have the smallest shell parameters as counted by rings on carapaces compared to others in the same age group (Figure 2). Among males of *E. orbicularis*, the maximal CL was 205mm measured on the turtles in East Azerbaijan.

In the PCA, the CL has a high loading on the first axis and accounted for 81% of the total variance, whereas the NW showed a high loading on the second axis. Figure 3 shows that the Golestan population is distinctly separated from others by the first factor.

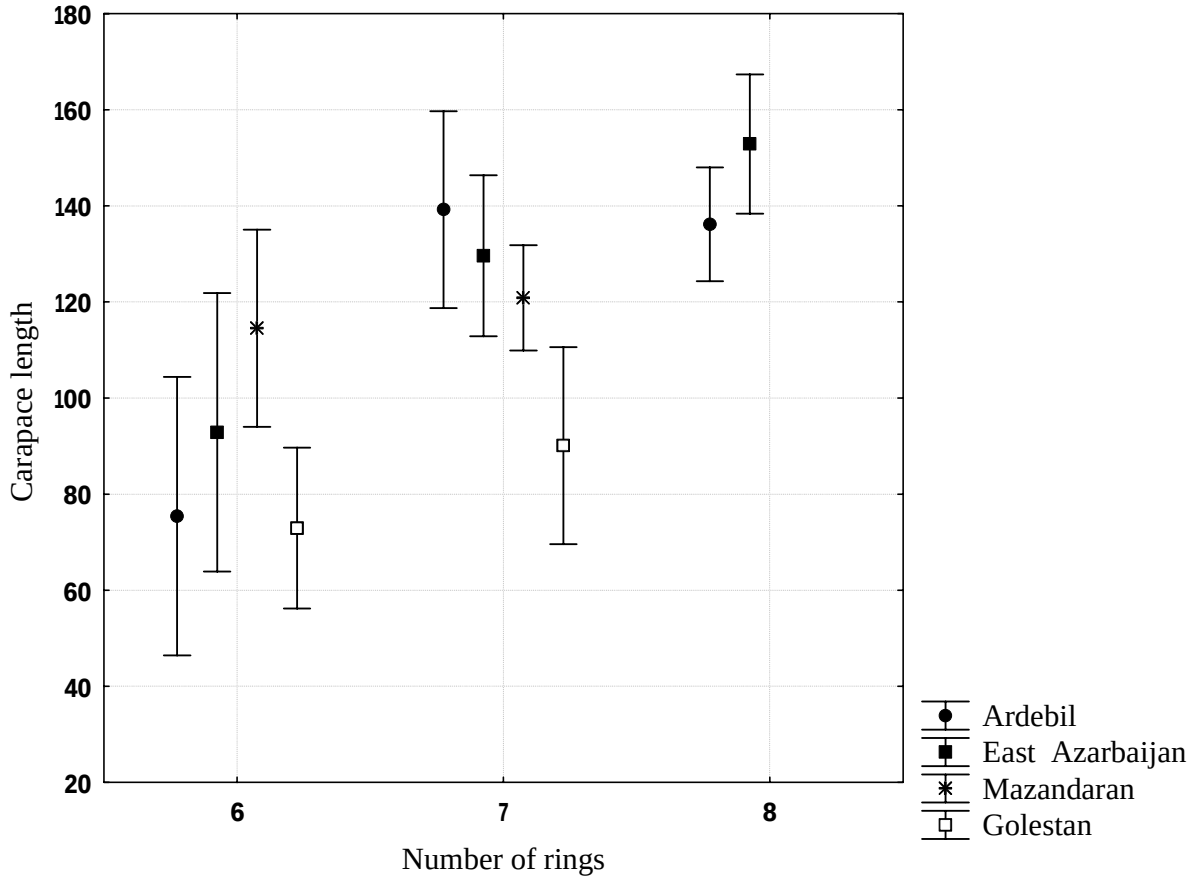

FIGURE 2. Carapace lengths vs. age group estimated by number of rings on carapace of turtle from four populations.

DISCUSSION

The morphological data on *E. orbicularis* is now well documented for most of the known distribution area (Kosareva 1969; Najbar & Szuszkiewicz 2006; Ayaz et al., 2007; Siroky et al., 2009, etc.). However, morphology of the Iranian pond turtles is not well researched (Hojati et al., 2003, 2007; Kami et al., 2006), and information looking particularly at the variations between populations is almost unknown. Kami et al. (2006) and Hojjati et al. (2007) have shown the sexual dimorphism (91%) in *Emys orbicularis* populations.

In this study, the number of males of *Emys orbicularis* was greater than the number of females. Likely, it was influenced by the season during which all our sampling was done (April to September), when the males are more active and the females hidden in deeper water.

The temperature and thermal conditions are important factors affecting the growth rates of *Emys orbiculari* (Zuffi et al., 1999; Sommer et al., 2007). The Caspian Sea has different habitats, vegetation and landscapes. As we expected, the northern populations have larger CL compared to the southern populations, whereas the turtles of Golestan display the smallest size shells in the same age group of adults, as demonstrated by the number of rings counted on the carapace. These differences are presumably due to the unfavourable environmental conditions of the Golestan area where the waters are more brackish due to being a branch of the equally brackish Atrak River. Also, principle component analysis has revealed the dissociation of Golestan males from others (Figure 3).

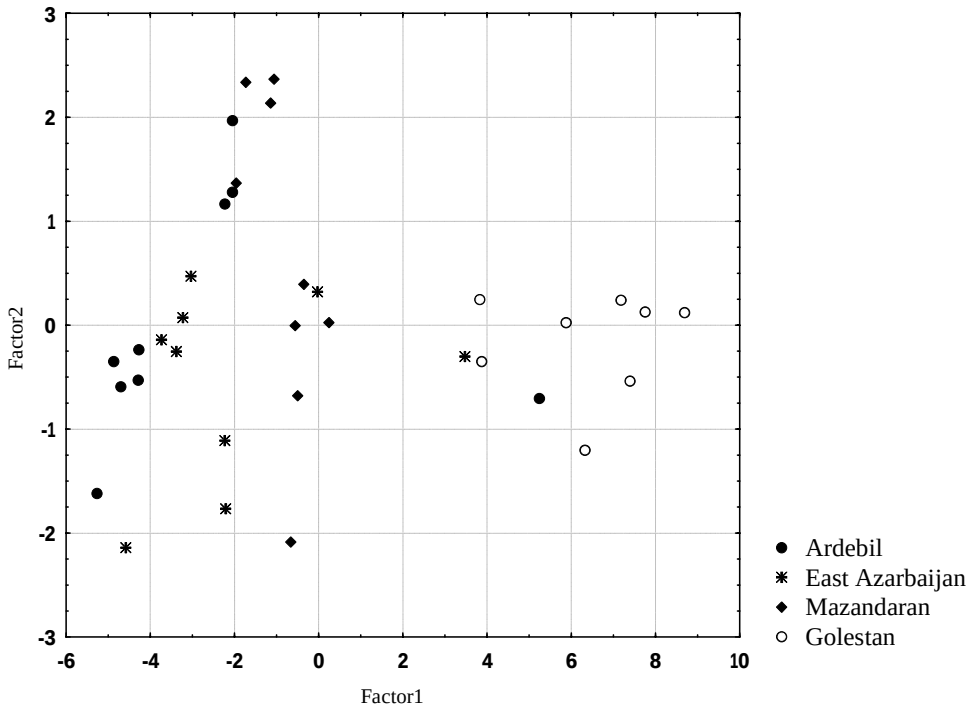

FIGURE 3. *Emys orbicularis* specimens of Ardeil, East Azerbaijan, Mazandaran and Golestan plotted in principle variant space.

Emys orbicularis from our sampling sites are able to connect along the coastal area of the Caspian Sea and some differences in size can be explained by their geographical positions. The localities in particular of Ardebil and East Azerbaijan are in the mountainous region and have higher habitat altitude than Golestan and Mazandaran. There are no significant morphological differences between Ardebil and East Azerbaijan populations, although the East Azerbaijan population is separated from other populations by the Elburz and Zagros mountain ranges and situated inland far from the coast of the Caspian Sea. It is likely that the turtles from the Caspian Sea can reach the East Azerbaijan from the northern territory through the Aras River system where there are no high mountains. According to the molecular study conducted by Fritz et al. (2007), the lineages of the Iranian (Goletan, Mazandaran and Gillan) *Emys orbicularis* belong to a single clade which includes the populations from Armenia, Turkey, and Azerbaijan and are distributed along Kura River. Our results indicate similarity in the morphology of *Emys orbicularis* from different geographical locations in Iran and that most likely they belong to the same subspecies.

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