MORPHOLOGY, GROWTH AND REPRODUCTION OF THE NON-INDIGENOUS TOPMOUTH GUDGEON *PSEUDORASBORA PARVA* (TEMMINCK ET SCHLEGEL, 1846) IN THE WETLAND OF ALMA-GOL, NORTHERN IRAN

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Observation of topmouth gudgeon was actually the first record of its being in this wetland, indicating increasing of its distribution in new habitats. So, morphological characters, growth and reproduction of this species as newly introduced non-indigenous fish into Iran were studied in the Alma-Gol wetland (northern Iran) during a period from September 2000 to August 2002. Inter-sexual comparison of morphological characters revealed that there are significant differences in total length, head width, A-C distance and dorsal fin rays between sexes. The maximum age of the fish studied was 3+ years and 4+ for females and males respectively. Observed lengths-at-age were different between sexes, with males longer and heavier than females in all age groups. The slope of the total length-weight relationships differed significantly between sexes, being negative allometric for both sexes. The overall ratio of males to females was 1.625:1. The highest average values of GSI were 11.93 and 6.98 for females and males respectively in spring samplings. Absolute fecundity estimates ranged from 965 to 2930, with a mean value of 2214.34 ± 445.24(SD) eggs.

Key words: *Pseudorasbora parva*, morphology, age and growth, wetland, Iran.

Introduction

Uncertainty about non-indigenous species in the protected areas such as wetlands poses a risk for sustainable management and protection measures of these areas. The basic data on non-indigenous species provide an insight into the life history patterns of these species that could be of use in conservation programs (Mack *et al.* 2000). Topmouth gudgeon *Pseudorasbora parva* of the family Cyprinidae, appears to be a newly introduced non-indigenous fish to Iran (Abdoli, 2000). The mode of introduction of this species into Iran is unknown. Its original distribution includes the rivers of southeast of Asia (www.briancoad.com). To our knowledge, no detailed studies of the species have been exclusively conducted in the southern Caspian basin. The references with very limited data on this fish from this basin are that of Abdoli (2000) and Naderi and Abdoli (2004), dealing with some morphological and biological characteristics.

Within new habitats, topmouth gudgeon populations are subject to a variety of environmental conditions. Since Mann et al. (1984) demonstrated strong influence of the local environment on life history traits of fishes; several studies have reported variability in population traits as phenotypic expressions in fishes, both within and between populations (Mazzoni and Iglesias-Rios, 2002; Kume *et al.* 2003). Therefore, in order to clarify phenotypic plasticity of population-based traits, our objective was to determine the growth and growth traits of topmouth gudgeon in the wetland which provides an insight into life history of this species.

Material and Methods

The study was carried out in the international wetlands of Alma-Gol. The wetland is located in the north of Iran on the Turkmen step near boundary of Turkmenistan, which is semi isolated lake (Scott, 1995) (Fig. 1). The lake has connection with Atrak River seasonally. Currently, the fish fauna of the wetland consists of 6 species, predominately Cyprinids. Profound changes have occurred in the composition of the fish community due to the introduction of non-indigenous species (Patimar, 2008).

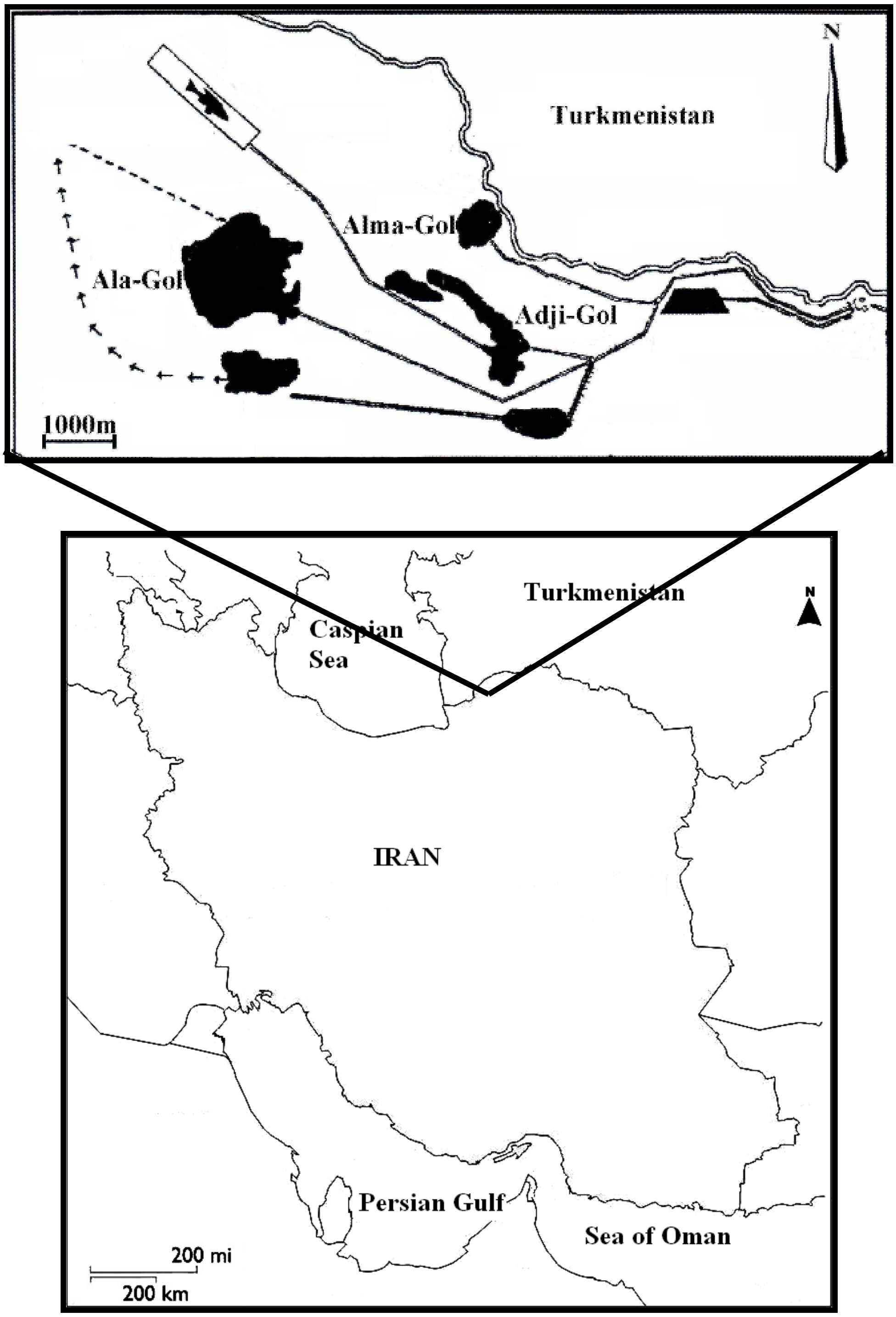

Figure 1: Location of the Alma-Gol and Ala-Gol wetlands in the south Caspian, Iran.

Between autumn 2000 and summer 2002, a total of 92 specimens were captured; sampling was performed using beach-seine (mesh-sizes: 3mm) twice per season.

Fresh specimens were examined in the laboratory. Morphological measurements were taken according to Holcik (1989) for 20 measurable characters (listed in table 1) and five meristic characters: lateral line scales (L.L.), scale rows below lateral line, scale rows above lateral line, dorsal soft fin rays and anal soft fin rays. Total length and weight were then measured to nearest 1 mm and gram by an electronic analytical balance (± 0.01g) respectively for all fish sampled. 5-10 scales removed from a standard position (second row of scales just under the front edge of dorsal fin) from right side of the body. Scales were mounted on glass slides and reviewed for banding patterns using a binocular microscope under reflected light at 10-25×. The relationship between the total length and total weight were determined by fitting the data to a potential relationship in the form of: $W=aL^b$, where W is the weight in grams, L the total length in centimeters, a and b are the parameters to be estimated, with b being the coefficient of allometry (Ricker, 1975).

The comparison between the average values of condition factor for seasons and for sexes was carried out by analysis of variance (ANOVA). An analysis of co-variance (ANCOVA) was performed to test significance differences in weight–length relationship between sexes. Differences in sex ratios between populations of wetlands were analyzed by chi-square tests. Statistical analyses were performed with SPSS 11.5 software package and a significant level of 0.05 was accepted.

Results

20 measurable and 5 meristic characters are shown in table 1 and 2. Inter-sexual comparison of the characters revealed that there are significant differences in total length, head width, A-C distance and dorsal fin rays between sexes.

Table 1: Mean± S.D. for measurable l characters (% TL) of Topmouth gudgeon *Pseudorasbora parva* from Alma-Gol wetland, Northern Iran

Character	Male (n=56) $\overline{X}$ ±S.D.	Female (n=28) $\overline{X}$ ±S.D.
Total length	67.41±4.88	54.87±2.01
Maximum body depth	18.60±1.12	18.64±1.24
Minimum body depth	8.94±1.47	8.99±0.79
Caudal peduncle length	20.90±0.93	21.43±1.30
Head length	10.36±1.31	10.87±0.91
Head width	7.12±0.55	7.49±0.89
Snout length	9.07±0.62	9.36±0.62
Post-orbital distance	6.14±0.48	6.96±0.79
Horizontal diameter of eye	4.02±1.49	4.11±1.55
Pre-dorsal distance	19.72±1.57	18.98±1.54
Dorsal fin depth	13.18±1.11	12.11±1.20
Anal fin depth	15.27±0.93	14.07±1.15
Pectoral fine length	14.69±0.95	14.17±1.06
Ventral fin length	17.74±2.62	19.08±1.37
P-V distance	16.68±2.55	17.01±1.34
V-A distance	18.26±1.06	18.21±1.54
A-C distance	23.50±1.48	23.94±1.23
D-V distance	40.42±3.49	40.13±1.71
D-A distance	23.89±2.04	23.53±1.86
D-C distance	15.15±1.02	18.17±0.69

Table 2: Mean± S.D. for meristic characters of Topmouth gudgeon *Pseudorasbora parva* from Alma-Gol wetland, Northern Iran

Character	Male (n=56) $\overline{X}$ ±S.D.	Female (n=28) $\overline{X}$ ±S.D.
L.L. scales	7.17±0.46	6.96±0.33
Scale rows below L.L.	6.02±0.33	5.93±0.26
Scale rows above L.L.	32.00±0.69	31.75±0.58
Dorsal soft fin rays	4.00±0.00	4.00±0.00
Anal soft fin rays	5.02±0.15	5.03±0.19

Scale reading showed that the maximum age of the fish studied was 3+ years and 4+ for females and males, respectively. In the collected specimens, the largest was a male with 82 mm TL and 4.03g total weight. In the population, observed lengths-at-age were different between sexes (ANCOVA, P<0.05), with males longer and heavier than females in all age groups (Table 3).

Table 3: Mean observed length (mm) and weight (gr)-at-age for Topmouth gudgeon *Pseudorasbora parva* from Alma-Gol wetland, Northern Iran

	Male	
Age	TL±S.D	TW±S.D
1+	33.9±0.109	0.95±0.310
2+	58.8±0.179	1.86±0.212
3+	66.9±0.327	2.73±0.469
4+	78.5±0.495	7.85±0.495

	Female	
Age	TL±S.D	TW±S.D
1+	32.6±0.112	0.63±0.239
2+	53.2±0.009	1.39±0.122
3+	56.3±0.144	1.66±0.289

The total length-weight relationships were evaluated for males and females (table 4). A significant relationship with the high regression coefficient (r > 0.92) was found between the length and weight of topmouth gudgeon. The slope (*b* value) of the total length-weight relationships differed significantly between sexes (ANCOVA, F=12.88, P>0.05), indicating different growth models. Growth model was negative allometric for each of considered groups, because the *b* value was significantly different from 3 (Pauly's test, t_{male}=12.276, t_{female}=5.474, t_{pooled}=9.011, P>0.05).

Table 4: Results of various relative growth estimations (weight-length relationship: $W=aTL^b$) for Topmouth gudgeon *Pseudorasbora parva* from Alma-Gol wetland, Northern Iran

Group	a	b	Error of b	Significance	r^2	F_{value}
Female	0.010	2.93	0.03	<0.05	0.78	22.79
Male	0.014	2.73	0.02	<0.05	0.89	176.88

Of the total number of individuals were sexed, males were dominant, the overall ratio of males to females was 1.625:1 in the wetland, and chi-square analysis showed significant differences from the ration 1:1 ((χ^2=4.76, $p<0.05$). The smallest mature specimen in both sexes was 2+ years old.

The GSI was calculated for each sex seasonally. The GSI values of males were significantly lower than those of females (t-test, $p>0.05$). The highest average values of GSI were 11.93 (with a maximum recorded value of 19.49) and 6.98 (with a maximum recorded value of 11.76) for females and males, respectively, in spring samplings (March-April samplings). It thereafter decreases sharply in early summer when the values were low (GSI-female: 3.94; GSI-male: 1.15), showing start of the resting period.

Absolute fecundity estimates ranged from 965 to 2930, with a mean value of 2214.34 ± 445.24(SD) eggs. Comparison of different regression models has shown that power regression is the most suitable model to describe the relation of absolute fecundity to total length and weight. General relations of absolute fecundity to total length and weight are given below:

Absolute Fec. = $1014.35TW^{1.623}$
(R=0.76, F=15.15, $p<0.05$)

Absolute Fec. = $0.028TL^{6.60}$
(R^2=0.60, F=6.12, $p<0.05$)

Discussion

This study has established some key morphological and biological parameters of Topmouth gudgeon *P. parva* in the new habitat. As far as known, phenotypic and life-history variables of organisms often vary among habitats because of predictable changes in important environmental factors. The investigation of this variation is an important task in fish ecology. Therefore, phenotypic and life history characteristics of the population under consideration can have important evolutionary consequences. It is rather difficult to describe the current position of *P. parva* in Iranian waters because of the lack of basic biological information on the different populations in this area. This species is assumed to be inadvertently transplanted to the Caspian Sea basin with breeding stock of commercially important cyprinids (Abdoli, 2000). However, observation of this non-indigenous species in the wetland (south-east Caspian Sea) indicates that its range distribution extends over south Caspian basin, and both widely distributed and well established.

For the population studied in the wetland, our observed largest specimen of both sexes was larger than that of reported by Abdoli (2000) for the topmouth gudgeon population from Avans reservoir (southeast Caspian Sea). In the population under consideration, the lateral line scales (L.L.) and scale rows above lateral line numbers were less than that of population inhabiting Avans reservoir (southeast Caspian Sea), while the mean number of dorsal soft fin rays and anal soft fin rays were more than that of the population from the reservoir (female: D7, A5.9; male: D7.1, A6.1). This variation in maximum size and morphological traits may be interpreted as phenotypic plasticity to new environments, an essential factor in introduction processes of non-indigenous fishes

The lifespan of the population in the studied wetland was the same as reported by Abdoli (2000), with 5 age groups being evident (maximum age-class: 4+). The habitats of this species in the southeast Caspian Sea are lake type water bodies such as wetland and reservoir, habitats with almost stable conditions, characteristics which might have determined the maximum longevity for the fish. Variation in age composition and longevity could be explained on the basis of the different exploitation patterns and/or ecological conditions. In this sense, while the topmouth gudgeon is not subject to commercial exploitation in the south Caspian basin, environmental conditions seem to affect significantly the life history parameters of this species.

The exponents of total length-somatic weight relationship of topmouth gudgeon, estimated in the wetland, showed that the somatic weight grows allometrically (Ricker, 1975) with the total length. Differences between males and females in the TL–W relationship are explained by the differences in size distribution of the two sexes as a consequence of inter-sexual differences in growth, suggesting the convenience of using the appropriate estimate from those proposed for each group when calculating weights by sexes. Higher values in females than in males, apparently suggesting a different fish condition of fitness between sexes. However, such conclusion must be regarded with caution, mostly when there is no the same data on populations from different localities, because geographic location and associated environmental conditions can affect the value of "b" (Bagenal and Tesch, 1978).

In the wetland of Alma-Gol, the overall sex ratio is unbalanced in favour of males, probably as a consequence of the higher survival rate of males. The observed sex ratio was unlike that found by Abdoli (2000), proposed the M:F as 1:1.2 in the Avans reservoir (southeast Caspian Sea). In fact, it seems that the differences in sex are highly significant throughout range distribution of this species.

From maximum recorded GSI values, it is evident, that reproductive season of the topmouth gudgeon is spring in the wetland. In comparison with other cyprinid species in the basin, topmouth gudgeon has higher GSI values for both sexes. This may be interpreted as an increase of reproductive effort which, in turn, promotes a rapid increase in the number and distribution of *P. parva* as a successful invasive species. However, such conclusion must be regarded with caution, mostly when there is no the same data on populations from different localities. The fecundity-body weight relationship can probably be used to discriminate between the different stocks of the same species due to variable growth rates in different localities (Hotes *et al.*, 2000). According to our results, the correlation coefficient of the relationship between fecundity and fish weight was higher than that of the relationship between fecundity and total length.

Conclusion

Morphological and life history characteristics of topmouth gudgeon *P. parva* is important with respect to management of the species, under consideration point to being simple, flexible fish and easily adapted to its habitat, which, in turn, may be interpreted an adaptive response that promotes a rapid increase in the number and distribution of this species. Bye (1984) suggested that successful species are the ones with the most phenotypic flexibility. The phenotypic and life history patterns of the *P. parva* population are in agreement with a strategy adopted for different environments and suggest that populations are responding to environmental characteristics to improve fitness locally. These findings need to be confirmed by experimental studies.

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