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Age and Growth of Brown Trout (*Salmo trutta*) in Six Rivers of the Southern Part of Caspian Basin

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Abstract: Problem statement: Because of dramatic declines in stocks of brown trout in southern part of Caspian basin, the population's structure of brown trout (*Salmo trutta*) in several rivers were studied to provide data for conservation programs. **Approach:** The structure of the populations in the six rivers of the southern part of Caspian basin including: Keliyare, Khojirood, Lar, Shirinrood, Rig cheshme and Pajimiyane, were studied. **Results:** Five age classes, ranged from 0^+-4^+ years, were determined. The most frequent age classes belong to 1^+ and 2^+. The length ranged from 78-305 mm and weight ranged from 3.6-390 g. Also, the condition factor ranged from 0.58-1.47. The highest and lowest length, weight and condition factor were observed in Lar and Rig cheshme, respectively. In 5 out of 6 rivers, females were dominant over males. The highest and lowest female: Male ratios were observed in Pajimiane (6.75:1) and Khojirood (0.8:1), respectively. Significant relationships were found between total length of brown trout with depth ($r = 0.6$, $p<0.0001$) and width ($r = 0.68$, $p<0.0001$) of habitats in these studied areas. **Conclusion:** According to our knowledge, this is the first report of brown trout from Kelyare and Khojirood rivers. Since size of populations in studied areas are small and majority of these rivers located in low protected locations, it is essential to apply serious measures to protect these vulnerable habitats.

Key words: Brown trout, age, growth, Caspian basin

INTRODUCTION

The brown trout, *Salmo trutta*, is a native species for Iran. This species prefers cold upstream and mountain lakes with rich oxygen contents and feeds from small fishes and aquatic insects. The brown trout has economic and conservation values. Many of them are caught by sport fishermen every year in Lar and other regions. Unfortunately, the populations of brown trout are declining as a result of overfishing, water pollution, habitat destruction, drought (Abdoli, 2000). To support conservation programs, basic knowledgments must be provided (Elliott, 1989). The study of weight-length relationship and condition factor are useful because they have also been used for the comparison of species growth between regions (Koutrakis and Tsikliras, 2003).

Also, the length-weight relationship helps in predicting the condition, reproductive history and life history of fish species (Nikolsky, 1963; Pauly, 1993; Wootton, 1992). The abundance of trout depends on conservation of natural river and stream habitats, as well as on their protection during the trout spawning period (Skrupskelis *et al*., 2006).

There is a lack of information on biological traits of brown trout in Iran. The aim of present study was to provide information about basic biological traits of brown trout in six main rivers in north part of Iran. In addition, it was hypothesized that the lengths of brown trout correlate with sizes of their habitats.

MATERIALS AND METHODS

Fish were caught from six rivers including Kelyare, Khojirood, Lar, Pajimianeh, Shirinrood and

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Rigcheshme located in Mazandaran province, north part of Iran, during autumn of 2006 using an electrofishing gear (200-300 volt). The shocked samples were collected using a net (mesh size 5 mm) installed downstream. In the laboratory, total length of specimens were measured to the nearest mm and total weight determined using a digital balance to an accuracy of 0.01 g. Scales were used to determine fish age. The Condition Factor (CF) was calculated according:

$$CF = (W/L^3)\times 100$$

Where:
W = The wet weight (g)
L = Total length (cm)

The relation of weight to length was calculated according:

$$Ln (W) = ln(a)+bln(TL)$$

The instantaneous growth rate was calculated according (Bagenal, 1978):

$$G = (\log w_{t+1}-\log w_t)/\Delta t$$

The Pearson's correlation was used to test relationships between sizes of habitat with lengths of brown trout. The width and depth of each river were considered as indexes of habitat sizes. Statistical analyses were carried out using SPSS (version 14) and Excel.

RESULTS

Significant relationships were found between length and weight in studied rivers (Table 1). The highest and lowest length and weight observed in Lar and Rigcheshme rivers, respectively. The highest age class was 4^+ years. The widest ranges for age classes (0^+-4^+) were observed in Shirinrood and Lar rivers (Fig. 1). The highest and lowest female: Male ratio were observed in Pajimiane and Khojirood, respectively. The condition factor ranged from 0.58-1.47 (Table 2).

Table 3 shows the physico-chemical properties of water in studied rivers. Significant relationships were found between total length of brown trout with depth ($r = 0.6$, $p<0.0001$) and width ($r = 0.68$, $p<0.0001$) of habitats in these studied areas.

Table 1: The length-weight relationships of brown trout in studied rivers

Location	Equation	R^2	n
Kelyare	lnTW = 3 lnTL-11.6	0.95	30
Khojirood	lnTW = 3.4 lnTL-13.5	0.97	9
Lar	lnTW = 3.2 lnTL-13.3	0.97	35
Pajimiane	lnTW = 3.1 lnTL-11.9	0.99	31
Rigcheshme	lnTW = 3.4 lnTL-13.7	0.93	25
Shirinrood	lnTW = 3.2 lnTL-12.6	0.98	41

Table 2: The mean length, weight and condition factor of different ages of brown trout in studied rivers (mean ± SEM)

Age	Total length (mm)	Total weight (g)	Growth rate	Condition factor
Kelyare				
1^+	102.60±1.74	10.34±0.60		0.94±0.025
2^+	151.10±5.80	33.96±2.49	0.520	0.99±0.047
Khojirood				
1^+	121.98±4.90	20.42±2.22		1.12±0.012
2^+	152.30±4.93	36.05±3.55	0.250	1.03±0.100
3^+	175.68	71.56	0.300	1.32
Lar				
1^+	128.99±6.46	24.21±4.52		1.12±0.150
2^+	184.05±6.28	82.17±10.01	0.530	1.21±0.035
3^+	236.09±5.58	167.95±13.69	0.310	1.25±0.035
4^+	255.05±17.35	209.05±42.44	0.100	1.24±0.001
Pajimiane				
1^+	106.30±1.1	13.12±0.53		1.08±0.018
2^+	143.65±17.24	37.35±14.26	0.450	1.10±0.030
3^+	238.35±13.45	159.20±22.34	0.630	1.17±0.030
Rigcheshme				
0^+	82.90±1.88	41.90±0.27		0.73±0.010
1^+	99.88±1.41	7.78±0.045	0.270	0.75±0.02
Shirinrood				
0^+	109.00±1.27	13.34±0.86		1.03±0.040
1^+	129.66±1.44	23.99±0.94	0.130	1.09±0.017
2^+	157.80±3.01	45.22±3.59	0.270	1.13±0.033
3^+	185.50	64.88	0.157	1.01
4^+	305.44	390.00	0.780	1.37

Table 3: The physio-chemical characteristics of studied rivers (mean ± SEM)

Location	Depth (m)	Width (m)	pH	Salinity (‰)	TDS (mg.L^{-1})	EC (μ sec.m^{-1})
Shirinrood	0.31	4.80	8.38±0.06	0.300	266.30±3.01	538.00±6.79
Pajimiane	0.23	3.20	8.53±0.05	0.211±0.011	173.60±3.25	375.70±12.5
Khojirood	0.37	2.75	8.53±0.10	0.200	231.30±6.82	467.11±15.8
Kelyare	0.15	2.40	8.56±0.03	0.210±0.01	169.76±3.92	342.00±6.85
Rigcheshme	0.20	2.90	8.64±0.08	0.110±0.01	156.31±10.7	259.22±29.48
Lar	0.35	7.00	8.70±0.10	-	206.00±70	491.00±51.00

Table 4: The mean length, weight and condition factor of different sex and sex ratio of brown trout in studied rivers (mean ± SEM)

	Kelyare		Khojirood		Lar	
	Male	Female	Male	Female	Male	Female
TL (mm)	137.45±11.59	110.94±4.23	149.93±8.14	146.01±11.72	203.03±10.55	196.98±9.53
W (g)	25.12±5.51	15.08±12.13	40.89±8.72	31.06±5.76	112.41±18.05	110.62±14.7
CF	0.89±0.046	0.97±0.025	1.14±0.06	1.014±0.15	1.15±0.035	1.27±0.03
Female: Male	3.3:1		0.8:1		1.2:1	
	Pajimiane		Rigcheshme		Shirinrood	
TL (mm)	112.80±2.37	120.65±7.48	101.84±2.32	92.92±2.2	139.89±4.79	139.47±8.31
W (g)	16.23±0.86	27.06±7.85	8.40±0.58	6.13±0.56	33.41±3.8	41.23±15.99
CF	1.13±0.03	1.08±0.02	0.79±0.01	0.74±0.02	1.15±0.02	1.06±0.02
Female: Male	6.75:1		1.5:1		1.3:1	

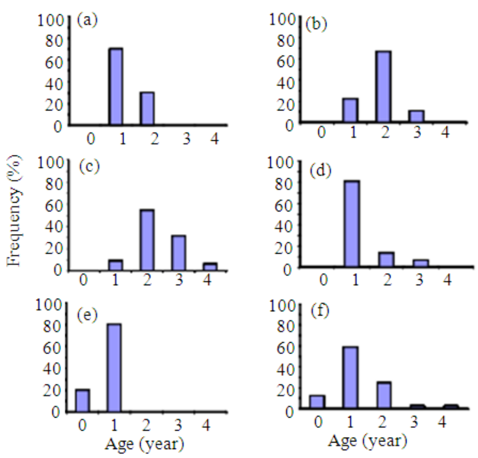

Fig. 1: The frequency of different ages of brown trout in studied rivers; (a) Kelyare; (b) Khojirood; (c) Lar; (d) Pajimiane; (e) Rigcheshme; (f) Shirinrood

DISCUSSION

According to the results of present study, the brown trout exhibited large among-rivers variation in biological traits (Table 4). The variations in biological traits are most likely to be a consequence of a mixture of factors interacting together. One of the main factors that may be responsible is the size of habitat. Jonsson *et al*. (2001) concluded that several traits of brown trout are strongly influenced by habitat variables associated with the size of small nursery streams.

In Mosquito Fish *Gambusia affinis* (Baird and Girard) the water level has been found to influence body size of adults (Skrupskelis *et al*., 2006; Stearns, 1983a; 1983b). Also, in salmonids, there are differences in adult size among freshwater resident and sea run migratory morphs from the same populations (Jonsson and Jonsson, 1993) and in Arctic Charr *Salvelinus alpinus* (L.), body size varies among phenotypes exploiting different habitats of the same lake, as a consequence of food abundance and habitat constraints (Jonsson *et al*., 1988; Jńasson *et al*., 1998).

In addition, brown trout smolt size increases with latitude, probably as an effect of decreasing water temperature towards the north (Jonsson and L'Abée-Lund, 1993; L'Abée-Lund *et al*., 1989).

The impact of species diversity on trout growth in young age groups can be accounted for by interspecific competition for food and shelter (Vehanen *et al*., 1999). A different situation was observed in older age groups 2^+ and 3^+, where the highest growth rate was recorded in the central lowland region and was significantly different from those of the other two regions. This can be attributed to the predatory nature of 3-year and older trout (Jonsson and Jonsson, 1999; L'Abee-Lund *et al*., 2002) that represent the top of the trophic chain in trout streams.

Besides, the trout growth rate in the above age groups was found to be higher in rivers with higher species diversity, which explains the diet of adult trout. Fish communities that are richer in species diversity are usually more abundant**,** therefore trout finds more potential food items.

One of the other main factors that may be responsible for change in the size at maturity is fishing mortality. Maturity responses such as decrease in size at maturity may mirror reduction in population size (Trippel, 1995). Most studies indicate that a decrease in size at maturity is caused by compensatory responses to declining population size and/or by genetic selection. The compensatory responses are based on density dependent mechanisms (Bowering and Brodie, 1991; Diana, 1983; Healey, 1980; Nikolsky, 1963) while genetic selection of early maturating fish is a consequence of a high level of stock exploitation. Maturing at a younger age and smaller size may allow individuals to contribute in one or two spawning seasons before they are captured with selective fishing gear because larger individuals are less likely to survive to reproduce (Cardinale and Modin, 1999).

Obvious differences were observed in sex ratio for studied rivers. Maitland and Campbell (1992) mentioned that the number of males in migrating trout populations was more abundant than females. In the freshwater fish the number of males in the early life stages becomes higher than that of females, but in the upper ages the rate of males decreases (Nikolsky, 1963).

CONCLUSION

According to our knowledge, this is the first report of brown trout from Kelyare and Khojirood rivers. Since size of populations in studied areas are small and majority of these rivers located in low protected locations, it is essential to apply serious measures to protect these vulnerable habitats.

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