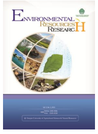

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The influence of environmental parameters on the abundance of monkey goby, *Neogobius pallasi* (Berg, 1916), in Kaboodval and Shirabad Streams, Golestan Province, Iran

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Abstract

The aim of this study was to determine the influence of environmental parameters on the abundance of monkey goby *Neogobius pallasi*. A total of 526 and 163 individuals of monkey goby specimens were caught by electro-shocker in the Kaboodval and Shirabad Streams, respectively. The ranges of total length of the specimens in Kaboodval and Shirabad Streams were respectively 22-137.55 mm and 32.64-137.97 mm. All the specimens of both streams belonged to the 5^{th} age group (0^{+}-4^{+}). The morphological, hydrological, biological and physicochemical parameters were investigated in both streams. The results showed that the hydrological parameters and vegetation coverage in the Kaboodval Stream and also, water velocity and depth in the Shirabad Stream had significant relationship with the monkey goby abundances ($P<0.05$). There was no significant difference between physicochemical parameters and monkey goby abundances in both streams. Moreover, the positive effect of elevation and negative influence of distance to road were observed but they were not significant.

Keywords: Environmental parameters, Monkey goby, Kaboodval Stream, Shirabad Stream.

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Introduction

Rivers and streams as one of the most important habitats for inland water aquatics, have not received due attention in relevant studies. Studying the ecology of rivers and streams needs information about their physical structure, national and topographical situation and also, biotic and abiotic parameters. Streams are located in different climates, vegetation coverage, topography and geology and their biological communities are also affected by human activities and regional and global climate changes. Different environmental parameters are effective in the density and diversity of biological communities, such as hydrological parameters (Marchetti and Moyle, 2000; Lamouroux and Cattane´o, 2006), physical parameters e.g. the kind of substrate and vegetation coverage (Growns *et al*., 2003) as well as chemical parameters (Matthews, 1998; Lappaleinen and Soininen, 2006). It is important to understand the effects of environmental parameters on the fish density and diversity and fish conservation. On the other hand, fish diversity modeling is very important in ecology (Guisan and Thuiller, 2005) and the influences of environmental parameters can helo in prediction of the species frequency. These models are usually utilized for better conservation and management of natural resources and ecosystems (Kennard *et al*., 2006). The biological and ecological studies of different fish species are necessary for stock conservation and recreation and provide an appropriate ecological recognition of the ecosystems (Kazancheev, 1981). Some researchers believe that in studies of water resources, fish communities should be considered more compared to other elements (Bagenal, 1978).

Several species of family Gobiidae are known as marine species and live in brackish and saline waters. Approximately 37 species and sub-species of Gobiidae exist in the Caspian Sea (Rahimov, 1986); however, there are some species of Gobiidae that permanently live in fresh water (Berg, 1964; Barimani, 1977; Abdoli, 1999). One of the fresh water species in this family is monkey goby, *Neogobius pallasi* (Berg, 1964), which has been reported as an endemic species in the Caspian Sea in some studies (Kiabi *et al*., 1999) and as a none-native and invasive species from Europe in some other studies (Biro, 1972; Skora and Stolarski, 1993).

In the study conducted in the non-Iranian coasts of the Caspian Sea (Rahimov, 1986), it is found that creation of sub-species and native populations in the Caspian Sea depends on the differences in climate, depth, salinity, water temperature, kind of substrate and other environmental parameters in different areas. In addition, in other research performed in the Lake Balaton (Keresztessy, 1996), the presence of monkey gobies has been reported in the rocky-pebbly substrates with the high vegetation coverage. Patimar and Abdoli (2009) investigated the sensitivity of monkey goby population in relation with ecological parameters (flood) in the Zaringol Stream, Golestan Province of Iran.

In this study, the influences of different environmental parameters on the abundance of monkey gobies populations in two Kaboodval and Shirabad Streams were studied towards better conservation and management of this species living in fresh waters.

Materials and Methods

The study was performed in the Kaboodval and Shirabad Streams located in 36º 53′N-54º 54′ E and 36º 52′N-37º 57′E, respectively. These streams emanate from the northern slopes of the eastern Alborz Mountains and then join the Gorganrood River and finally empty into the Caspian Sea (Afshin, 1994). The sampling stations were determined according to their accessibility and the kind of substrate. Because of the short length of Kaboodval and Shirabad Streams, 5 and 3 sites were sampled from them in summer, respectively (Figure 1).

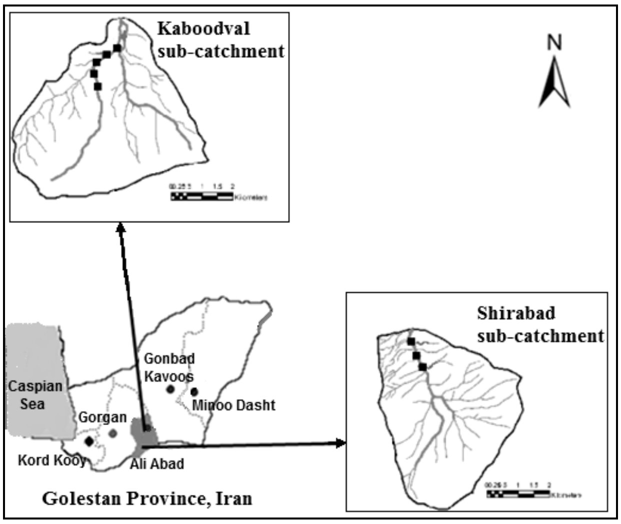

Figure 1. The study area and sampling stations (black squares) in Kaboodval and Shirabad Streams in Golestan Province, Iran.

The substrates of the Kaboodval and Shirabad Streams are composed of rock and pebble. Therefore, the specimens were collected by electro-shocker (1.7 KW; 100-200 V; 10 A. direct electricity) (Bagenal, 1978; Copp *et al*., 2005). All specimens were fixed in 10% formalin and transported to the laboratory. The body mass was weighed for each specimen to 0.1 g accuracy. Total length of the individuals were measured to 0.01 mm accuracy using a vernier caliper. The age of specimens was determined based on otoliths through a binocular microscope that magnified the ring patterns for 15 times.

The fish specimens were identified by identification keys (Abdoli, 1999; Kottelat and Freyhof, 2007; Coad, 2012). It should be noted that the scientific name of monkey goby has changed from *Neogobius fluviatilis* (Pallasi, 1814) to *Neogobius pallasi* (Berg, 1916) (Coad, 2012). Habitat variables can be classified by means of describing the size and features of streams (Allan, 1995). These variables include parameters in the stream basin (e.g. the elevation of study area, distance to road, the slope of study area and drainage), morphological parameters (e.g. the kind of substrate and stream width), hydrological parameters (e.g. the average of water discharge and stream depth), biological parameters (the percentage of vegetation coverage and the density of benthic macro invertebrates) and physicochemical parameters (e.g. water temperature, dissolved oxygen, phosphate, water turbidity, pH, EC and salinity). Physicochemical parameters were measured by Water Checker.

Fish Biomass

LeCren method which is based on catch per unit effort (CPUE), was used for determining the frequency of monkey goby populations in different stations. The specimens were collected two times in each station (Bagenal, 1978) and the number of specimens was measured by the formula below:

$$N = \frac{C_1^2}{C_1 - C_2}$$

where C_1 and C_2 are the first and second efforts of catching the specimens, respectively and N is the number of specimens.

Sampling of benthic macroinvertebrates

Different kinds of aquatic insects (Diptera, Ephemeroptera and Trichoptera), Crustaceans and fish larvae (in older specimens) have been mentioned as monkey goby nutrition in the inland waters of the southern Caspian basin (Abdoli, 1999; Abdoli and Rahmani, 2001). Therefore, the density of benthic macroinvertebrates can be an important biological parameter in the density of monkey gobies populations. The samples of benthic macroinvertebrates were collected by Surber sampler, fixed in 4% formalin and transported to the laboratory for counting and identification. The benthic macroinvertebrates were identified using the Atlas of Caspian Sea Invertebrates and other identification keys. Regression and correlation analyses were used for investigating the relationship between environmental parameters and the abundance of monkey goby populations in the Kaboodval and Shirabad Streams.

Results

Using several maps and applying necessary corrections and rectifications, different parameters of sub-catchments (e.g. elevation, slope, the mean distance to road and the density of drainages) were extracted and the influences of these parameters on the abundance of monkey goby populations were investigated. The comparison of slopes in the Kaboodval and Shirabad sub-catchments showed that the slope in Shirabad is higher than Kaboodval (Table 1).

Table 1. Comparison of different environmental parameters between the Kaboodval and Shirabad Streams in Aug. 2008.

Station / Parameter	1		2		3		4		5	
Stream	K	S	K	S	K	S	K	S	K	S
Physicochemical parameters										
Water temperature (°C)	15	15.6	15.6	15.8	15.9	16.2	16.2	-	17	-
pH	7.24	7.43	7.63	7.57	6.98	7.59	7.77	-	7.46	-
EC (µ mho/cm)	270	266	280	265	290	286	290	-	290	-
Turbidity (mg/lit)	5	3	11	2	11	2	40	-	16	-
Dissolved Oxygen (mg/lit)	9	8.4	8.9	8.3	9.1	8.6	7.8	-	8.3	-
Salinity (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	-
PO_4 (mg/lit)	0.11	0.19	0.14	0.25	0.22	0.41	0.34	-	0.28	-
Basin parameters										
Elevation	277.05	126.17	240	115.9	212.57	103.06	202.27	-	192.56	-
Slope (%)	55.5	32.94	6.85	22.05	1.33	3.68	4.18	-	7.33	-
Distance to road	50.03	18.13	10.16	105.92	22.24	40.87	9.45	-	125.77	-
Drainage	27.8	23.65	21	20.9	0	33.31	47.62	-	0	-
Hydrological parameters										
Discharge (m^3/s)	0.1	0.13	0.08	0.55	0.06	0.34	0.06	-	0.05	-
Velocity (m/s)	0.29	0.42	0.28	0.92	0.4	0.75	0.18	-	0.25	-
Coarse substrate (%)	21.06	85	18.75	45	5.27	70	2	-	1	-
Grained substrate (%)	78.94	15	81.25	55	94.73	30	98	-	99	-
Stream width (m)	3.6	4.3	3	4	1.8	3.5	3	-	2.4	-
Stream depth (m)	0.06	0.08	0.07	0.15	0.07	0.13	0.08	-	0.05	-
Vegetation coverage (%)	50	45	10	25	15	40	10	-	8	-

* K = Kaboodval Stream, S = Shirabad Stream

Station 1 in Shirabad sub-catchment showed the maximum distance to road. Also, the maximum distances to road in the Kaboodval sub-catchment were observed in stations 2 and 4. The abundances of monkey goby (*Neogobius pallasi)* did not show significant differences with drainage in the Kaboodval and Shirabad sub-catchments.

There was no significant change in physicochemical parameters of water in Kaboodval Stream. The comparisons between physicochemical parameters of water in Kaboodval and Shirabad Streams showed that these parameters in the two streams are similar. However, the amount of turbidity in Kaboodval Stream and phosphate in Shirabad Stream were higher. Comparisons of other parameters have been shown in Table 1.

The benthic macro invertebrates communities

A number of 11 orders of benthic macroinvertebrates were identified in both Kaboodval and Shirabad Streams. In Kaboodval Stream, the macroinvertebrates belonged to 4 phyla viz., Arthropoda, Platyhelminthes, Annelida and Mollusca. In contrast, in Shirabad Stream they belonged to 3 phyla: Arthropoda, Platyhelminthes and Mollusca. Diptera and Ephemeroptera were the dominant orders of macroinvertebrates in both streams (Table 2).

Table 2. The abundance of benthic macroinvertebrates (number per m^2) in the Kaboodval (K) and Shirabad Streams (S) in Aug. 2008.

Station / Macroinvertebrates	1		2		3		4		5	
Stream	K	S	K	S	K	S	K	S	K	S
Diptera	597.86	758.98	834.14	429.6	282.82	361.58	161.68	-	186.16	-
Ephemeroptera	128.88	895	50.12	293.56	46.54	748.22	110.98	-	82.34	-
Trichoptera	32.22	164.68	53.7	42.96	57.28	39.38	39.38	-	17.9	-
Plecoptera	0	78.76	0	57.28	3.58	14.32	3.58	-	0	-
Nematoda	7.16	0	0	10.74	0	0	3.58	-	7.16	-
Zygoptera	0	0	0	3.58	3.58	0	0	-	0	-
Gastropoda	7.16	0	21.48	3.58	17.9	0	0	-	0	-
Tricladida	0	3.58	7.16	0	0	0	0	-	0	-
Isopoda	3.58	10.74	0	10.74	0	21.48	0	-	0	-
Decapoda	0	-	3.58	-	3.58	-	3.58	-	0	-
Oligochatae	0	-	3.58	-	3.58	-	0	-	0	-
Gammaridae	-	39.38	-	0	-	0	-	-	-	-
Coleoptera	-	10.74	-	10.74	-	21.48	-	-	-	-
Hemiptera	-	0	-	0	-	3.58	-	-	-	-

* K = Kaboodval Stream, S = Shirabad Stream

Monkey goby populations

A total of 526 and 163 individuals of monkey goby populations were caught in the Kaboodval and Shirabad Streams, respectively. The ranges of total length of the specimens in Kaboodval and Shirabad Streams were 22-137.55 mm and 32.64-137.97 mm, respectively. All specimens of both streams belonged to 5 age groups (0^+-4^+) and the maximum and minimum abundances were respectively observed in the age groups 1^+ and 4^+ (Figure 2).

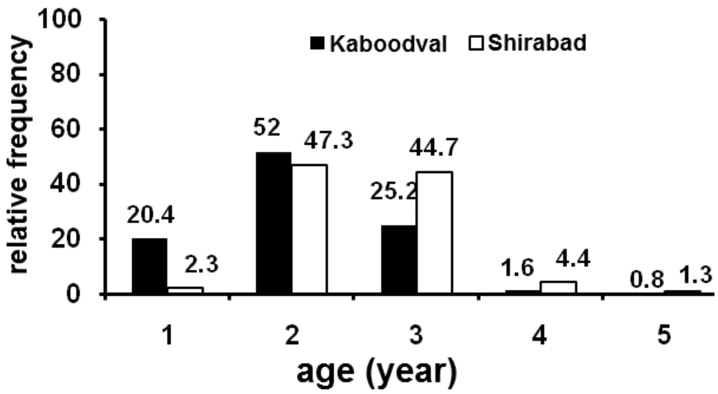

Figure 2. The relative abundances of the specimens of monkey goby caught in the Kaboodval and Shirabad Streams.

It should be noted that the majority of the specimens caught in both streams were released after noting the biological characteristics to preserve the fish stocks. The investigations showed that the maximum abundances of monkey goby populations in both Kaboodval and Shirabad Streams were observed in station 1. Totally, the abundance of monkey goby population in the Kaboodval Stream was greater relative to the Shirabad Stream (Table 3).

Table 3. The abundances of monkey gobies (the number of fish per m^2) in different stations of Kaboodval and Shirabad Streams in Aug. 2008.

Stream	Kaboodval					Shirabad		
Station	1	2	3	4	5	1	2	3
Density (the number of fish per m^2)	1.65	0.7	1.17	1.02	0.6	0.61	0.17	0.25

Hydrological Parameters

Among different hydrological parameters investigated in this study, only vegetation coverage was positively correlated with the abundance of monkey gobies in the Kaboodval Stream. Also, the stream width, the kind of substrate and discharge showed highly positive correlations with the abundance of monkey gobies in this stream but were not statistically significant. In Shirabad Stream, the water velocity and the stream depth showed negative significant correlations with the abundance of monkey gobies. Moreover, highly positive correlations were observed between the kind of substrate and vegetable coverage with the abundance of monkey gobies that were not statistically significant (Table 4).

Table 4. The influence of hydrological parameters on the abundance of monkey gobies in the Kaboodval and Shirabad Streams.

Stream / Parameter	Kaboodval		Shirabad	
	R	P	R	P
Discharge (m^3/s)	0.69	0.19	-0.93	0.23
Velocity (m/s)	0.08	0.68	-0.98*	0.05
Kind of substrate	0.84	0.15	0.88	0.31
Stream width (m)	0.9	0.09	0.66	0.53
Stream depth (m)	0.29	0.7	-0.99*	0.02
Vegetation coverage (%)	0.88*	0.04*	0.8	0.4

Physicochemical Parameters

In the Kaboodval and Shirabad Streams, the correlations between physicochemical parameters and the abundances of monkey gobies were not significant. Only the water temperature showed highly negative correlation with the abundance of monkey gobies in the Kaboodval Stream. When the water temperature increases in the downstream, the abundance of monkey gobies decreases, too. In the Shirabad Stream, there was a highly positive correlation between turbidity and the abundance of monkey gobies (Table 5).

Table 5. The influences of physicochemical parameters on the abundances of monkey gobies in Kaboodval and Shirabad Streams.

Stream / Parameter	Kaboodval		Shirabad	
	R	P	R	P
Water temperature (°C)	-0.76	0.13	-0.63	0.56
pH	-0.5	0.38	-0.96	0.18
EC (µ mho/cm)	-0.68	0.2	-0.3	0.8
Turbidity (mg/lit)	-0.52	0.36	0.98	0.1
Dissolved oxygen (mg/lit)	0.37	0.53	-0.01	0.98
PO_4 (mg/lit)	-0.49	0.39	-0.65	0.54

Basin Parameters

There was no significant relationship between basin parameters and abundance of monkey gobies in both Kaboodval and Shirabad Streams. In both streams, direct influence of elevation and inverse influence of distance to road on the abundance of monkey gobies were observed.

Biological Parameters

Our results revealed no significant relationships between the benthic macroinvertebrates communities and the abundances of monkey gobies in both streams (Table 6).

Table 6. The influence of benthic macroinvertebrate communities on the abundances of monkey gobies in Kaboodval and Shirabad Streams.

Parameter	Kaboodval		Shirabad	
	P	R	P	R
Diptera	0.5	0.83	0.25	0.92
Ephemeroptera	0.49	0.68	0.46	0.74
Trichoptera	0.65	0.34	0.14	0.97
Plecoptera	0.81	0.14	0.66	0.5
Nematoda	0.71	0.22	0.55	-0.64
Zygoptera	0.75	0.19	0.55	-0.64
Gastropoda	0.68	0.24	0.55	-0.64
Tricladida	0.46	-0.43	0.1	0.98
Isopoda	0.08	0.83	0.77	-0.34
Decapoda	-0.21	0.73	-	-
Oligochatae	0.74	-0.2	-	-
Gammaridae	-	-	0.1	0.98
Coleoptera	-	-	0.77	-0.34

Discussion

Both Kaboodval and Shirabad Streams originate from springs. The water arrives in a flat area with rocky substrate after passing the cascades and steep paths and then, flows into the downstream with rocky-sandy substrates. *Neogobius pallasi* usually exists in the middle parts of the rivers with rocky-pebbly substrate and water temperature between 5 to 20 °C (Abdoli, 1999). In this study, the investigation of physicochemical parameters showed appropriate ranges of water temperature with least change in Kaboodval and Shirabad Streams that creates proper habitats for monkey gobies. Additionally, the maximum abundances of monkey gobies were observed in the upstream with the coarser substrate and lower temperature in both streams.

The highest and lowest abundances of monkey gobies population (in m^2) in the Madarsu Stream in Golestan National Park have been reported in January 1996 in station 3 (0.75 fish per m^2) and June 1998 in station 3 (0.013 fish per m^2), respectively. The maximum biomass of monkey gobies in January 1996 was obtained as 4.88 g/m^2 and the minimum biomass was reported to be 0.21 g/m^2 in June 1998 (Abdoli and Rahmani, 2001). In this study, the highest and lowest abundances of monkey gobies were obtained in station 1 (1.65 fish per m^2) and station 5 (0.6 fish per m^2), respectively in the Kaboodval Stream. It has been respectively observed in station 1 (0.61 fish per m^2) and station 2 (0.17 fish per m^2) for Shirabad Stream. The maximum and minimum biomass of monkey goby populations in the Kaboodval Stream were 5.47 g/m^2 (in station 3) and 1.24 g/m^2 (in station 5). In Shirabad Stream, the maximum biomass was observed in station 1 (3.9 g/m^2) and the minimum biomass was seen in station 2 (1.34 g/m^2).

Comparisons of environmental parameters showed little differences between the Kaboodval and Shirabad Streams. In fact, the situations of these two streams are similar, whereas the abundance and biomass of monkey goby population in the Kaboodval Stream were higher than the Shirabad Stream. We postulate that environmental stresses caused by various changes in discharge and seasonal flood can be effective in this regard. The highest abundance of monkey goby population in both streams have been observed in station 1 (upstream). We suggest this is because of high vegetation coverage, rocky-pebbly substrate and high abundance of benthic macroinvertebrates.

One of the most important environmental parameters in the biological productivity of streams and other aquatic ecosystems is phosphorus (Dillon and Rigler, 1974; Jones and Bachmann, 1976; Smith, 1977). Several studies on streams have shown that there is a powerful relationship between phosphorus concentration and the abundance of fish (Hanson and Leggett, 1982). Therefore, it seems that physicochemical parameters such as turbidity, pH and dissolved phosphate show negative influence on the abundance of this species. More abundance of monkey gobies is usually observed in the channels with sandy substrate and lower water velocity in comparison to the aquatic ecosystems in flood plains with higher water velocity (Zhukov, 1965) and in the streams with the velocity less than 1 m/s (Abdoli, 1999). In this study, the water velocities in Kaboodval and Shirabad Streams were less than 1 m/s. Minimum abundance of monkey gobies was observed in station 2 with high water velocity (0.92 m/s) in both Kaboodval and Shirabad Streams. Therefore, in upstream areas, the abundance of monkey gobies which have low ability of swimming in strong currents of water is more than downstream areas.

The elevation and slope are important in bringing about change in water temperature and discharge in streams. Kaboodval and Shirabad Streams are small streams which have little change in elevation, slope and water temperature between upstream and downstream. Therefore, non-significant effects of environmental parameters are acceptable.

Keresztessy (1996) reported that the monkey goby usually exists in lakes covered by 30% vegetation, with rocky and pebbly substrates, low concentration of dissolved oxygen (≈ 5.5 mg/lit) and a pH close to 7 (Bilko, 1966; Baimov, 1970). The substrates of the Kaboodval and Shirabad Streams are rocky-pebbly (especially in the upstream) with some grained sediments. The vegetation coverage and the abundance of monkey gobies showed significant relationship in the Kaboodval Stream that is acceptable, because the vegetation coverage is effective in increasing the abundance of benthic macroinvertebrates which are known as the monkey gobies nutrition. The vegetation coverage surrounding the streams influences on the benthic macroinvertebrates communities which is effective in the fish species diversity and the increase in fish abundance (Rahel and Hubert, 1991). However, the insect larva are very important as monkey gobies nutrition in the stream habitats but the benthic macroinvertebrates and the abundances of monkey gobies did not show significant relationships in the Kaboodval and Shirabad Streams.

Conclusion

This research showed that among the hydrological parameters, vegetation coverage in the Kaboodval Stream and water velocity and depth in the Shirabad Stream had significant relationship with the monkey goby abundances ($P<0.05$). There were no significant differences between physicochemical parameters and monkey goby abundances in both streams. In addition, the positive effect of elevation and negative influence of distance to road were not significant. It seems that many environmental parameters are effective in the density and diversity of monkey goby populations. Therefore, separating the effect of each parameter needs further investigations.

References

Abdoli, A. 1999. Inland Water Fishes of Iran. Nature and Wildlife Museum Publications, 377p. (In Persian)

Abdoli, A., and Rahmani, H. 2001. Investigation of nutrition diet of two species of monkey gobies, *Neogobius melanostomus* and *Neogobius fluviatilis* in Madarsu Stream, Golestan National Park. Journal of Agricultural Science Natural Resources. 1, 3-15.

Afshin, I. 1994. Rivers of Iran. Ministry of NIRO. 575p.

Allan, J.D. 1995. Strean ecology structure and function of running waters. Chapman and Hal. 388p.

Bagenal, T. 1978. Methods for assessment of fish production in freshwater, Third edition, Blackwell Scientific Publication Oxford. London Edinbargh Melbourn. 365p.

Baimov, U.A. 1970. Food of the monkey goby (*Neogobius fluviatilis* (palls.)) in the Aral Sea. Vopr. Ikhtiol. 10, 175-178 (In Russian).

Barimani, A. 1977. Ichthyology and fisheries. Urmia University Publications, (Vol. 2): 245p. (In Persian)

Berg, L.S. 1964. Freshwater fishes of the U.S.S.R and adjacent countries. Volume 2, 4th edition. Israel Program for scientific Translations Ltd, Jerusalem, 553p.

Bilko, V.P. 1966. Local stocks of industrial gobies in the Dnieper-Bugsky liman. Biol. Morphol. Ryb sanit biolog. Rezh. Prisn. UkrNaukova Dumka, Kiev. pp. 131-136 (In Ukrainian).

Biro, P. 1972. *Neogobius fluviatilis* in Lake Balaton – a Ponto-caspian goby new to the fauna of central Europe. Journal of Fish Biology. 4 (2), 249-255.

Biro, P. 1995. A folyami geb (*Neogobius fluviatilis* Pallas) novekedese es tapleka a Balaton parti oveben (Dynamics and food of monkey goby (*Neogobius fluviatilis* Pallas) in Lake Balaton. Halasza´t. 88, 175-184.

Biswas, S.P. 1993. Manual of Methods in fish Biology. South Asian publishers Pvt Ltd, New Dehli. 157p.

Borcea, I. 1934. Revision systematique et distribution geographique des gobiides de la mer Noire particulierement des eaux Roumanies.–Annual Science University Jassy. 19 (1/4), 1-136.

Coad, B.W. 2012. The freshwater fishes of Iran. Family Gpbiidae Genus *Neogobius*. www.Briancoad.com. 06 April. 2012.

Copp, G.H., Bianco, P.G., and Bogutskaya, N.G. 2005. To be, or not to be, a non-native freshwater fish? Journal of Applied Ichthyology. 21, 242-262.

Dillon, P.J., and Rigler, F.H. 1974. The phosphorus- chlorophyll relationship in lakes. Limnology and Oceanography. 19, 767-773.

Growns, I., Gehrke, P.C., Astles, K.L., and Pollard, D.A. 2003. A comparison of fish assemblages associated with different riparian vegetation types in the Hawkesbury-Nepean River system Fisheries Management and Ecology. 10, 209-221.

Guisan, A., and Thuiller, W. 2005. Predicting species distribution: offering more than simple habitat models. Ecology Letters. 8, 993-1009.

Hanson, J.M., and Leggett, W.C. 1982. Empirical prediction of fish biomass and yield. Canadian Journal Fisheries Aquaculture Science. 39, 257-263.

Jones, J.R., and Bachmann, R.W. 1976. Prediction of phosphorus and chlorophyll levels in lakes. Journal of Water Pollutantion Control Federation. 48, 2176-2182.

Kazancheev, E.N. 1981. Ryby Kaspiiskogo Morya [Fishes of the Caspian Sea]. Legkaya i Pischchevaya Promyshlennost, Moskva. 167p.

Kennard, M.J., Pusey, J.B., Arthington, A.H., Harch, B.D., and Mackay, S.J. 2006. Development and application of a predictive model of freshwater fish composition to evaluate river health in eastern Australia. Hydrobiologia. 572, 33-57.

Keresztessy, K. 1996. Thereatend freshwater fish in Hungary. In: A. Kirchhofer and D. Hefti (Eds), Conservation of Endangered Freshwater fish in Europe: 73-77. Birkhauser, Basel.

Kiabi, B.H., Abdoli, A., and Naderi, M. 1999. Status of the fish fauna in the South Caspian Basin of Iran. Zoology in the Middle East. 18, 57-65.

Kottelat, M., and Freyhof, J. 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol, Switzerland. 646p.

Lamouroux, N., and Cattane´o, F. 2006. Fish assemblages and stream hydraulics:consistent relations across spatial scales and regions. River Research and Applications. 22, 727-737.

Lappaleinen, J., and Soininen, J. 2006. Latitudinal gradients in Niche bread than dposition–regional patterns in freshwater fish. Naturwissenschaften. 93, 246-250.

Marchetti, M.P., and Moyle, P.B. 2000. Effects of flow regime on fish assemblages in a regulated California Stream. Ecological Applications. 11, 530-539.

Matthews, W.J. 1998. Patterns in freshwater fish ecology. London: Chapman and Hall. 756p.

Patimar, R., and Abdoli, A. 2009. Fish species diversity of Zaringol Stream (eastern Alborz Maountains-Golestan Province). Journal of Agricultural Science and Natural Resources. 16 (2), 72-81.

Poff, N.L., Brinson, M.M., and Day, J.W. 2002. Aquatic ecosystems and global climate change: potential impacts on inland freshwater and coastal wetland ecosystems in the United States. Pew Center on Global Climate Change, Arlington, Virginia. 44p.

Rahel, F.J., and Hubert, W.I. 1991. Fish Assemblages and Habitat Gradients in a Rocky Mountain–Great Plains stream: Biotic Zonation and Additive Patterns of Community Change. Transactions of the American Fisheries Society. 120 (3), 319-332.

Rahimov, D.B. 1986. Zoogeographical analysis of Gobiid fishes of Caspian Sea. Proceeding of 5th Congress of Hydrobiological Associaton, Academy of Science of USSR, Taliatti. pp. 113-114.

Rahmani, H. 1999. Investigation of some biological and ecological characteristics of two species of monkey gobies in Madarsu Stream in Golestan National Park. BS Fisheries project. Gorgan University of Agricultural Sciences and Natural Resources. 43p.

Sattari, M. 1999. Parasites of sturgeons (Chondrostei; Acipenseridae) from souh-west of Caspian Sea. Ph.D. Dissertation, the University of Tehran, Iran. 280p (In Persian).

Skora, K.E., and Stolarski, J. 1993. New fish species in the Gulf of Gdansk Neogobius sp. [*Neogobius fluviatilis* (Pallas 1811)]. Bulletin of the sea Fisheries Institute. pp. 1-83.

Smith, R.V. 1977. Domestic and agricultural contributions to the inputs of phosphorus and nitrogen to Lough Neagh.Water Research. 11, 453-9.

Sweeney, B.W., Jackson, J.K., Newhold, J.D., and Funk, D.H. 1992. Climate change and the life history and biogeography of aquatic insects in eastern North America. In: Firth, P., Fisher, S.G. (Eds.), Global Climate Change and Freshwater Ecosystems. Springer-Verlag, New York. pp. 143-176.

Zhukov, P.I. 1965. [Fishes of Byelorussia]. Nauka i tekhnika, Minsk. 416p (In Russian).