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Original Article

Habitat use of *Alburnoides namaki* in the Jajroud River (Namak Lake basin, Iran)

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Abstract: A fish species prefer a particular habitat where provides its biological requirements, hence, understanding their habitat use and preferences are crucial for their effective management and protection. This study was conducted to assess the habitat use and selection patterns of *Alburnoides namaki*, an endemic fish in Jajroud River, Namak Lake basin, Iran. The river was sampled at 18 equally spaced sites. A number of environmental variables, including elevation, water depth, river width, river slope, velocity, substrate type, average diameter of bed stone, riparian vegetation type and total dissolved solid (TDS) and the relative abundance of *A. namaki* were recorded at each site. The results showed that *A. namaki* mostly selects upper parts of the river with higher slope, higher depth, lower width, lower velocity, bed rock substrate i.e. bed with boulder cover, TDS of 100-150 ppm, and deciduous forest and residential area riparian type compared with the available ranges. This study provides the habitat use and environmental factors affecting on the distribution of *A. namaki* in the Jajroud River.

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Introduction

Increasing anthropological activities particularly in riverine ecosystems have changed their physico-chemical features threatening the survival of their inhabitants. Riverine ecosystems includes about 0.001% of water resources of our planet, nevertheless they include almost half of the fish species i.e. its species diversity is 7500 times greater than other aquatic systems in terms of fish biodiversity (Helfman et al., 2003). A fish species prefer a particular habitat where provides its biological requirements (Throw, 1997). Many environmental parameters are considered to be important for influencing habitat preference of fish (Yu and Lee, 2002). Hence, understanding their habitat use and preferences are crucial for their effective management and protection (Torgersen and Close, 2004; Tejerina-Garro et al., 2005; Tabatabaei et al., 2015) due to providing the relationship between environmental factors and aquatic communities (Rashleigh et al., 1995).

Spirlins, the members of the genus *Alburnoides*, a member of cyprinid family is found in Europe, Asia Minor and Central Asia with 25 species (Coad, 2015). Until 2009, all populations of *Alburnoides* species in Iran were known as *A. bipunctatus* in Iranian inland waters. Based on the recent researches, seven species have been reported from Iranian inland water (Coad, 2015; Mousavi-Sabet et al., 2015; Jouladeh-Roudbar et al., 2015). Among them, the endemic *Alburnoides namaki* Bogutskaya and Coad, 2009 was found in the rivers of the Namak Lake basin.

Members of the genus *Alburnoides* are lithophilic and rheophilic fishes, which inhabit in barbel and grayling zones (Breitenstein and Kirchhofer, 2000; Tahami et al., 2015). They are very sensitive to human activities and levels of dissolved oxygen (Čihař, 1999). In European waters, spirlins are extremely threatened and nearly close to extinction

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because of their sensitivity (Kirchhofer, 1997; Lusk et al., 1998). The freshwater fishes of Iran are also faced to recent severe droughts, climate change, pollutions, introduction of exotic fishes and anthropogenic impacts, and as a consequence, many fish populations have been intensively affected especially sensitive fishes, like the members of the genus *Alburnoides* (Esmaeili et al., 2014a, b; Tahami et al., 2015).

Little information is available regarding biology and ecology of the endemic *A. namaki*, and its habitat use and selection are unknown. Therefore, this study was conducted to assess the habitat use and selection patterns with regard to habitat availability of this endemic species in the Jajroud River.

Materials and Methods

Study area: The Jajroud River, in the Namak Lake basin, locates 30 km of the northeast of Tehran (Tehran Province, Iran) and originates from the central Alborz Mountains at Klon-e Bastak Mountains at the north of the Darbandsar village (Fig. 1). This River drains to the Latian Dam and afterward flows toward the Mamlou Dam. The approximate length of the river is 40 km with a basin of about 710 km^2 and the mean slope of 4%. The samplings were carried out between Letian (N:35°46'10", E: 51°41'25") and Mamlou Dams (N: 35°43'42", E: 51°41'49"), since the area before Letian Dam was not available because of its protection by Environment Department and the river after the Mamlou Dam was dried during sampling period.

Sampling was started after Latian Dam distributed in elevational profiles (to downstream) to cover all available habitats along the river in October and November 2012 through 18 equally spaced (about 100 m) sites, during daylight hours. The elevation (m) and geographic coordinates were recorded for each site to ±10 m using GPS (Global Positioning System; Garmin) (Torgersen and Close, 2004), and the river and sampling locations were mapped using ArcGIS 9.3 (Fig. 1). Fish were sampled in 10-15 m stretches of the river using a backpack electrofishing

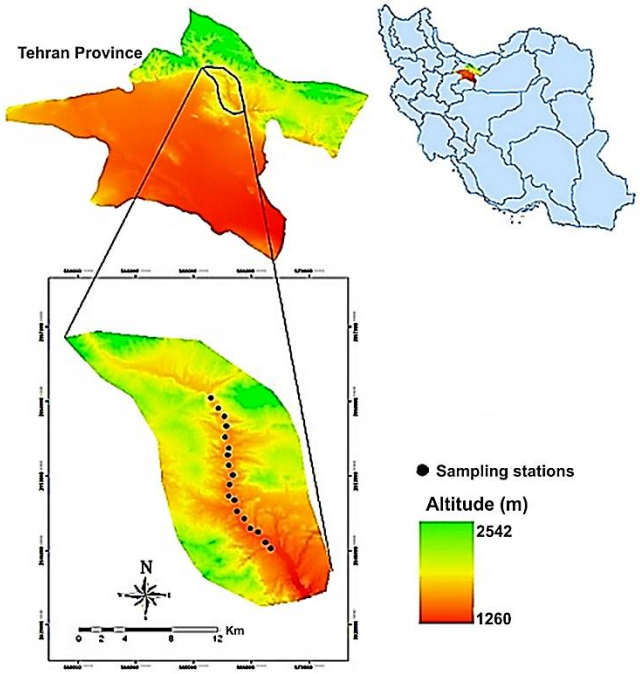

Figure 3. Location of Tehran Province, Jajroud River, and sampling stations.

Table 1. Explanation and abbreviation for each categorical habitat variable.

Substrate (mm)		Riparian vegetation type	
Bedrock	>4000	BV	Deciduous forest
Boulder	256-4000	BM	Deciduous forest and residential area
Cobble	64-265		
Pebble	16-64	A	Grasslands or herbs
Gravel	2-16	BA	Largely unvegetated
Sand	<2		

device (Samus Mp750, 45 cm diameter, aluminium ring anode) in the downstream–upstream direction using upstream and downstream stop-nets of 2 mm mesh. For sampling, one-removal method with similar catch-per-unit effort strategy was employed (Klaar et al., 2004). Fish specimens were collected from each site during 30 min, anesthetized in clove powder solution (1 g l^{-1}), identified according to Coad (2015), counted, photographed, and finally placed in slow moving water along the river bank to recover and return to the river.

Habitat Data: Since there is limited or no knowledge available on *A. namaki* studied here, the environmental variables were selected according to the results of other studies conducted on other fishes (Chuang et al., 2006; Rifflart et al., 2009; Tabatabaei

et al., 2015). The habitat data were measured immediately after sampling (Yu and Lee, 2002). The measured variables include elevation (m), water depth (cm), river width (m), river slope (%), velocity (cm/s), substrate type (Table 1), average diameter of bed stone (cm), riparian vegetation type and Total Dissolved Solid (TDS) (ppm).

Elevation of sampling sites were recorded by GPS (Garmin). The mean depth (cm) of each site was estimated by measuring depth at 20 random points across sampling site using a measuring bar, and their average was considered as river depth (Lotfi, 2012). The mean width of river (m) was measured using a tapeline by measuring upper, middle and lower sections of each sampling site and their average was considered as river width. The mean slope (%) was measured by a clinometer (Suunto PM-5/360 PC; ww.suunto.com) at the midline of the river in three areas (beginning, middle, and end of each site). The surface velocity (m/s) was estimated by a simple float based on Hassanlie (1999), and repeated three times to minimize error. Dominant substrate type was determined both visually and randomly via measuring the diameter of the riverbed stones in 20 selected quadrate (50×50 cm) based on Lotfi (2012), and classified according to Johnston et al. (1996) and Tabatabaei et al. (2015). Bed stone diameter average also were calculated by measuring diameter of bed stones in 20 selected quadrate (50×50 cm) based on Lotfi (2012). Riparian vegetation type (based on the type of vegetation growing at riparian parts of the river or absence thereof), were classified according to our observations, photographs, and standard procedures with some modifications (Johnston et al., 1996). TDS was measured using a portable water quality instrument (WTW GmbH). The first seven variables were continuous, and other variables were nominal. The abbreviation and description for each discrete variable are presented in Table 1.

Habitat use and habitat selection: Habitat use, availability, and selection were calculated over the range of each environmental variable. Each environmental variable was divided into a series of intervals, and the mean relative abundance of each species in each interval was calculated using habitat selection (Habsel) software 1.0 (Jowett, 2014). The formula S= (%Uc,i)/(%Ac,i), where i is the interval of a given environmental variable c, %Uc,i is the percentage of utilization of a specific interval of an environmental variable c utilized by fish, and %Ac,i is the percentage of availability of this environmental variable (Guay et al., 2000; Waddle, 2001; Tabatabaei et al., 2015), resulted in a selectivity value (S) at each interval. Since no comparable study on microhabitat use of this species was available, therefore, only the specimens larger than 40 mm were selected and counted in each station for further analysis; because the habitat use of fishes in lotic systems can be strongly affected by ontogeny (Copp and Vilizzi, 2004; Gillette et al., 2006).

Results

All collected fish during sampling were belonging to four species viz. *Alburnoides Namaki*, *Capoeta busei*, *Capoeta caculata* and *Oxynoemacheilus bergianus* that were returned to the river after identification and counting. A total of 66 specimens of *A. namaki* were collected. The studied habitats in Jajroud River mostly occurred in an elevational range of 1422-1490 m above sea level, with 13-53 cm depth, 5-24 m width, 0.4-1.9 m/s water velocity, slope of 1.2-2%, stone diameter of 12-40 cm, and TDS of 100-286 ppm and cobble and then boulder substrate type, deciduous riparian forest, and with most available cover type of boulder (Fig. 2).

The habitat-use pattern of *A. namaki* generally followed habitat availability (Fig. 2). Considering the availability of environmental variables and the selectivity, the habitat selection pattern of this species mainly had the following features: elevation 1480-1490 m, water depth 35-45 cm, channel width less than 10 m, channel slope 1.8-2%, water velocity less than 1 m/s, bed rock substrate, average diameter of bed stone larger than 40 cm, deciduous forest and residential area riparian type, and TDS 100-150 ppm (Fig. 2)

The results revealed that *A. namaki* mostly selected upper parts of the river with higher slope and depth.

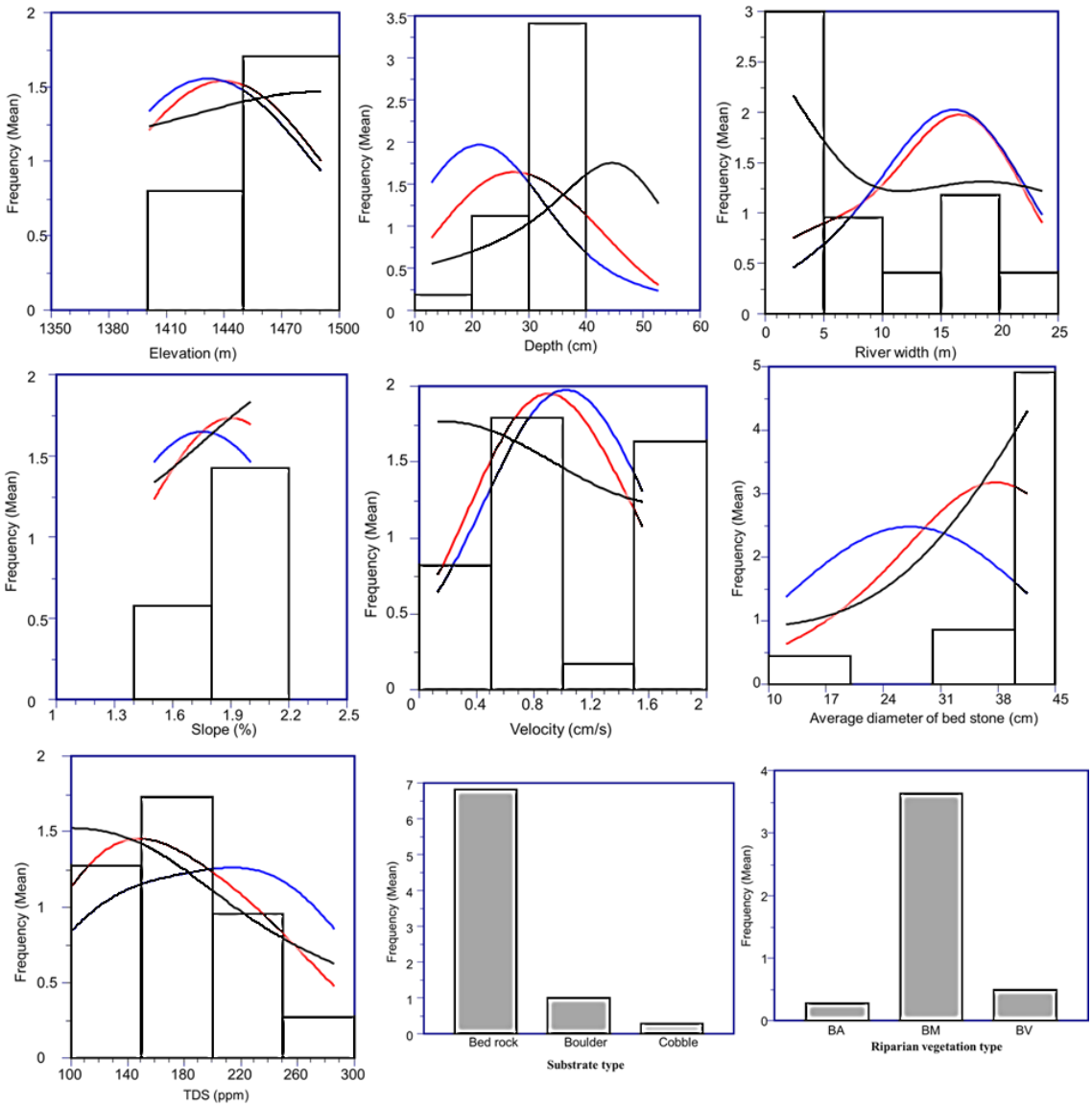

Figure 2. Habitat availability (blue line), used (Red line) and selected (black line) by *A. namaki* for environmental variables.

Furthermore, this species selects lower width and velocity, bed rock substrate i.e. bed with larger elements, deciduous forest and residential area riparian type, and boulder cover compared with the available ranges. In some cases, the pattern of habitat use was different from the pattern of habitat selection i.e. in water depth, river width and velocity.

Discussion

Most of endemic fish species with limited distribution are threatened due to destruction of their habitats. Hence, it is necessary to study their habitat use and selection patterns prior to endanger their survival in order to their effective management and protection (Rashleigh et al., 2004). The current study provided the habitat use and selection patterns, and environmental factors affecting on the distribution of *A. namaki*, an endemic fish of Iranian inland waters, in the Jajroud River that supplies drinking and agricultural water of Tehran Province and Khojir area. The members of the genus *Alburnoides* are very sensitive to levels of dissolved oxygen. Having low tolerance to water polluted by industrial, agriculture or urban wastes makes these cyprinid fishes a good biological indicator of the environment quality (Čihăr, 1999). In recent years, the industrial effluents in Jajroud region have been caused the disposal of industrial effluents and chemical

pollution of surface and groundwater waters including Jajroud River. Therefore, the findings of the present study can show the importance factors for effective management and protection of this endemic species.

The results revealed that *A. namaki* mostly selects deeper reaches with bed rock substrate and larger bed stones. Instream habitat structures provide a variety of functions for stream fishes (Quist et al., 2005; Tabatabaei et al., 2015); cover features provide protection from predators or ameliorate adverse conditions of stream flow or seasonal changes in metabolic costs and thereby influence fish survival and movement (MacKenzie and Greenberg, 1998; Tabatabaei et al., 2015). In addition, deep body shape of this specie can help to rapid turning and maneuvering in tight quarters as deeper reaches with substrate consisting large bed rocks that provides dead spaces to establish proper habitat. Furthermore, substrate type can be important for fish spawning and feeding behavior (Quist et al., 2005; Tabatabaei et al., 2015).

Aburnoides namaki mostly uses area with lower river width i.e. less than 10 m. Researches showed that habitat with higher river width have little suitability for fishes such as *Varicorhinus barbatulus* (Littlejohn et al., 1985; Chuang et al., 2006). In addition, deeper reaches with lower current, less river width and lower TDS along with larger bed stones can be provide transparent water to penetrate sunlight causing higher production of periphyton algae as main food items of the *Alburnoides* species (Treer et al., 2006).

Habitat use of the *A. namaki* is area with deciduous forest and residential area riparian type. This can be due to providing organic matters that considered as base of the primary production in the riverine ecosystems (Wootton, 1999). In addition, high organic matter depends on the presence of proper condition and enough time to decompose of allochthons such as lower water velocity and appropriate substrate. Hence, riparian type and bed cover are important factors in distribution of riverine fishes due to providing the major source of carbon and energy (Smokorowski and Pratt, 2007). Furthermore, the deciduous forest riparian vegetation type can be stabilize fish habitats by providing source of carbon and detritus during low production season e.g. autumn. This detritus are a ground to develop small animals such as invertebrate as base of the riverine food chain (Li et al., 2009).

The limitations of using an electrofishing device (Yu and Lee, 2002; Mercado-Silva et al., 2008), considering the limited sampling period and the variability of the habitat features within each station, may affect the efficiency of the sampling procedure. Fish habitat-use patterns may vary by changing the environmental conditions and be affected by seasonal patterns (Copp and Vilizzi, 2004; Gillette et al., 2006). Seasonal patterns were not assessed here, but the habitat use and selection patterns of *A. namaki* are indicative of autumn. Therefore, we recommend investigation of the habitat use and preference patterns in other seasons as well.

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چکیده فارسی

ترجیح زیستگاه ماهی *Alburnoides namaki* در رودخانه جاجرود (حوضه دریاچه نمک، ایران)

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چکیده:

یک گونه ماهی، یک زیستگاه ویژه، جایی که نیازمندهای زیستی آن فراهم می‌شود، را ترجیح می‌دهد. از این رو درک نحوه‌ی استفاده و ترجیح‌های زیستگاه برای مدیریت و حفاظت موثرشان ضروری است. این مطالعه به‌منظور ارزیابی نحوه استفاده و الگوهای انتخاب زیستگاه خیاطه‌ماهی نمکی، *Alburnoides namaki*، یک گونه‌ی بومزاد رودخانه جاجرود از حوضه دریاچه نمک ایران به اجرا درآمد. در مجموع از ۱۸ ایستگاه با فواصل تقریباً برابر در رودخانه نمونه‌برداری گردید. یک تعداد از متغییرهای محیطی شامل ارتفاع، عمق آب، عرض رودخانه، شیب رودخانه، سرعت، نوع بستر، قطر متوسط سنگ بستر، نوع پوشش گیاهی حاشیه رودخانه و کل مواد جامد محلول به‌همراه فراوان نسبی *A. namaki* در هر ایستگاه ثبت گردید. نتایج نشان داد که *A. namaki* بیشتر بخش‌های بالادست رودخانه با شیب بیشتر، عمق بیشتر، عرض کمتر، سرعت جریان کمتر، نوع بستر سنگی به عبارت بسترهایی حاوی تخته سنگ، TDS ۱۵۰-۱۰۰ و پوشش حاشیه‌ای جنگل برگریز و نواحی مسکونی را در مقایسه با محدوده‌های در دسترس انتخاب می‌کند. این مطالعه نحوه استفاده از زیستگاه و فاکتورهای محیطی موثر بر پراکنش *A. namaki* در رودخانه جاجرود را فراهم می‌کند.

کلمات کلیدی: ماهی‌خیاطه، آب‌شیرین، پارامترهای زیستگاهی، شاخص مطلوبیت زیستگاه.