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RESEARCH PAPER

Re-Description and New Distribution Area of an Endemic Anatolian Fish Species, *Alburnus nasreddini* Battalgil, 1944

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Abstract

In this research, the current systematic status of endemic Anatolian species, *Alburnus nasreddini*, has been enlightened by making its morphological description and comparing it with the closest species, *A. escherichii*. This species has distinguished from the closest species, *A. escherichii*, by fever perforated scales along lateral line (44-48 vs. 46-53), dipper body depth (26.64 vs. 23.92% SL), shorter snout (25.54 vs. 27.55% HL) and larger eye diameter (31.22 vs. 27.88% HL). Our study has also examined the distribution area and habitat conditions of the species, clearly indicating that *A. nasreddini* distributed in only Akarçay basin (Eber, Akşehir and Karamık lakes; Selevir and Seyitler reservoirs; Kalli, Adıyan and Akşehir creeks) and Ilgın Lake Basin (Beşgöz Springs-Sarayönü, Aşağı Çiğil Creek-Ilgın). Its observable population until very recently has disappeared from its type locality, Eber Lake, due to heavy pollution. Although its population present in Akşehir Lake is critically endangered due to the drought, presence of viable population in some dam lakes (especially in Selevir Reservoir) is considered as a promising picture with regard to the future of species.

Keywords: Akarçay Basin, inland fish fauna, Nasreddin bleak, taxonomy.

Introduction

Fahire Battalgil, one of the first ichthyologists of Turkey, has described 25 species of inland water fish, 10 of which is *Alburnus* (Özuluğ, Özuluğ, Ekmekçi & Turan, 2012). However, most of these species have not been accepted valid for long in systematic records. This has been resulted from not doing the detailed species description as is being done today and from the lack of type materials and figures. For this reason, it has been pointed that study on new samples is mandatory to clarify Battalgil's species (Özuluğ & Freyhof, 2007a).

Of 24 species belonging to the genus *Alburnus* living in Turkey's inland waters, 15 are endemic (Bogutskaya, 1997; Bogutskaya, Küçük & Ünlü, 2000; Çiçek Birecikligil & Fricke, 2015; Elp, Şen & Özuluğ, 2015; Özuluğ & Freyhof, 2007a, b), including Nasreddin bleak (*Alburnus nasreddini*). However, distribution areas of *A. derjugini*, and *A. schischkovi* from these 24 species are uncertain (Kottelat & Freyhof, 2007; Özuluğ & Freyhof, 2007a, b). In addition, systematic status of *A. kotschy* and *A. sellal* are controversial, and *Alburnus akili* and *A. nicaeensis* are EX (Freyhof *et al*., 2014; Küçük, 2012).

Enough information on its morphology and distribution range hasn't been given in original description of *A. nasreddini* (Battalgil, 1944). Fish samples collected from Eber Lake by C. Kosswig were recorded as new species and named in honour of "Nasreddin Hoca" by Battalgil (1944) (Figure 1). However, morphology of this species has been superficially compared with *A. escherichii* (Sakarya River basin) and *A. albidus* (Sapanca Lake, valid name is *A. istanbulensis*) and most important differences between these species have been indicated as follows: number of scales on lateral line, number of branched rays on pectoral fin, and morphology of the stripe extending from back of the eye to caudal fin base (Battalgil, 1944). According to Bogutskaya (1997), taxonomic state of *A. nasreddini* is quite controversial. Although the morphology of species is close to *A. alburnus* and *A. escherichii*, it differs from them by fewer branched rays of anal fin and bigger scales. *A. nasreddini* was reported to be a valid species in subsequent studies (Freyhof *et al*., 2014; Özuluğ & Freyhof, 2007a, b).

In our study, systematic state of *A. nasreddini* has been revealed by making its morphological re-description. The recent status of distribution area and habitats has also been given along with its some bio-

ecological features.

Materials and Methods

In our more intense field surveys carried out between April and June 2015 using sample collection tools (gillnet, seine-net and electroshock etc.), no specimen of *A. nasreddini* was caught from the type locality, Eber Lake. However, *A. nasreddini* specimens were collected from Kalli Creek and Selevir Reservoir located in the drainage basin of Eber Lake. *A. escherichii* samples as comparative material were collected from Porsuk Stream (Sakarya River basin) and all fish specimens were preserved in 10% formalin.

Material is deposited in: IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University. Counts and measurements follow Kottelat and Freyhof (2007). All measurements were point to point and made with digital calipers (0.1 mm sensitive). Other metrics include head width1 (the distance between the anterior eye margins), head width2 (the distance between the posterior eye margins), head width3 (head width at the nape), head depth1 (head depth through the eye), head depth2 (head depth at the nape), and the snout width (measured at level of the nostrils). The perforated lateral-line scales were counted from the anteriormost scale (the first one to touch the shoulder girdle) to the posteriormost one; the last two branched dorsal and anal fin rays articulating on a single pterygiophore were counted as 1½.

Results and Discussion

Material Examined: *A. nasreddini*: IFC-ESUF 03-0376, 19, 84.14-116.32 mm SL; Afyonkarahisar prov.: Kalli Creek; F. Küçük, SS. Güçlü, İ. Gülle, 12 June 2015. –IFC-ESUF 03-0373, 85, 84.93-96.77 mm SL; Afyonkarahisar prov.: Selevir Reservoir; F. Küçük, S.S. Güçlü & İ. Gülle, 12 June 2015. *A. escherichii*: IFC-ESUF 03-0340, 29, 75.50-92.73 mm SL; Eskişehir prov.: Porsuk Stream (Yörükkırka Village); F. Küçük, S.S. Güçlü & A.Vişne, 04 September 2012.

Morphology: General appearance is shown in Figures 1,2 and 3; morphometric and meristic data are given in Tables 1 and 2. Body is deep and markedly compressed laterally, its depth at dorsal-fin origin 26.64 (24.14-28.20) and anal-fin origin 21.93% (20.43-23.28%) SL. Dorsal and ventral profile markedly convex. Head is small and its length is 24.95% SL, and snout is markedly pointed and its length is 25.54% HL. Mouth is slightly superior and uppermost point of cleft is at level of centre of eye above. Lower jaw-quadrate junction is on vertical through anterior margin of the pupil, eye diameter is about 26.57-34.35, mean is 31.22% HL. Pelvic-fin origin in front is about 4-5 scales of dorsal-fin origin and a well-developed scaleless ventral keel in front of the anus reaching 6-7 scales forward. Anal-fin origin

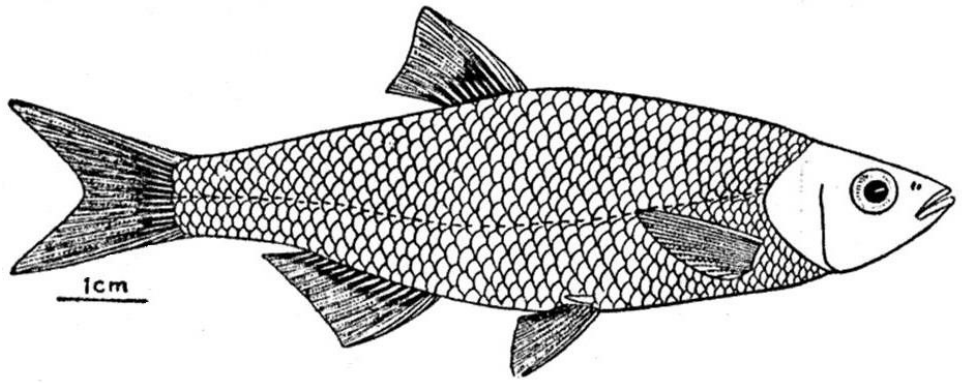

Figure 1. *A. nasreddini* original drawings (from Battalgil, 1944).

Figure 2. *A. nasreddini* about 109 mm SL, Selevir Reservoir (alive colour) (IFC-ESUF 03-0373).

below dorsal-fin branched rays 8-9. Caudal fin is deeply forked and lobes pointed. Pelvic fin is short, not reaching anus and pelvic axillary lobe is long, margin of dorsal fin is straight and anal fin is slightly concave, pectoral fin margin is slightly and pelvic fins margin is markedly rounded. Largest recorded specimen is about 115.8 mm SL.

Colour: In alive specimens, dorsal area is olive green or light grey, flank and abdomen are silvery. A pale yellowish and pale violet external stripe along between the back of the eye and caudal fin base. All fins are transparent, dorsal and caudal fin membranes are light grey or smoky coloured (Figure 2). In formalin specimens, dorsal areas are light brown or greenish, pectoral area is silvery or slightly cream coloured. An inner axial stripe in preserved individuals faint grey colour (Figure 3), as in *A. escherichii* in Figure 4 and 5.

Sexual dimorphism: In males, there are dense little reproduction tubercules at head and predorsal

Table 1. Morphometric data of *A. nasreddini* (IFC-ESUF 03-0373, n=26) and *A. escherichii* (IFC-ESUF 03-0335, n=14)

	A. nasreddini	*A. escherichii*
Standard length (SL, mm)	77.18-115.79	76.72-106.33
SL%		
Head length	24.95 (23.33-26.71)	24.06 (22.18-26.20)
Body depth at dorsal–fin origin	26.64 (24.14-28.20)	23.92 (22.00-26.29)
Body depth of anal–fin origin	21.93 (20.43-23.28)	19.46 (18.16-20.96)
Predorsal length	57.47 (55.60-59.69)	56.20 (54.28-59.08)
Prepelvic length	48.67 (44.65-52.11)	48.73 (45.77-51.96)
Preanal length	67.78 (63.73-72.63)	67.95 (65.93-71.10)
Distance between pectoral and anal fin origins	45.75 (41.06-48.84)	44.87 (43.03-49.12)
Distance between pectoral and pelvic fin origins	25.53 (22.19-29.07)	24.99 (23.21-25.99)
Distance between pelvic and anal fin origins	20.65 (17.82-24.85)	20.83 (18.39-23.04)
Depth of dorsal fin	20.53 (18.75-22.52)	20.35 (19.03-22.18)
Depth of anal fin	17.43 (15.26-18.87)	16.58 (15.80-17.86)
Length of pectoral fin	20.92 (18.44-22.09)	20.28 (17.82-21.49)
Length of pelvic fin	16.67 (15.12-18.46)	15.61 (14.42-16.98)
Length of caudal peduncle	18.74 (16.73-20.59)	18.30 (16.87-20.36)
HL%		
Snout length	25.54 (21.77-28.37)	27.55 (25.68-30.67)
Eye diameter	31.22 (26.57-34.35)	27.88 (24.64-30.61)
Interorbital distance	30.65 (27.80-33.96)	31.76 (30.12-34.38)
Head width 1	29.43 (27.93-32.98)	29.43 (26.50-33.90)
Head width 2	44.57 (42.00-47.64)	43.67 41.16-47.37)
Head width 3	48.86 (44.63-52.81)	47.81 (45.86-50.19)
Head depth 1	53.26 (48.02-58.65)	53.25 (50.55-56.59)
Head depth 2	70.44 (64.73-75.92)	68.41 (65.20-73.11)
Internostril distance	20.15 (16.84-23.22)	20.01 (16.96-22.89)

Table 2. Frequency of occurrence of meristic characters in *A. nasreddini* and *A. escherichii*

	Lateral-line scales											
	n	44	45	46	47	48	49	50	51	52	53	Mean
A. nasreddini	25	1	2	10	7	5	-	-	-	-	-	46.5
A. escherichii	18	-	-	1	7	4	3	1	1	-	1	48.2
	Branched dorsal-fin rays					Branched anal-fin rays						
	n	7	8	9	Mean	12	13	14	15	Mean		
A. nasreddini	25	-	16	9	8.3	3	13	8	1	13.2		
A. escherichii	18	2	10	6	8.2	3	12	3	-	13.0		
	Scales above lateral line						Scales below lateral line					
	n	8	9	9½	10	Mean	2½	3	3½	4	Mean	
A. nasreddini	25	1	22	-	2	9.0	-	1	-	24	3.9	
A. escherichii	18	1	15	2	-	9.0	1	5	5	7	3.5	
	Gill rakers											
	n	14	15	16	17	Mean						
A. nasreddini	22	6	6	8	2	15.5						
A. escherichii	9	1	3	2	3	15.7						

area. These tubercules are also seen on first unbranched rays of the pectoral fin.

Battalgil (1944) stated in her first description that *A. nasreddini* distinguishes from the closest species (*A. albidus* and *A. escherichii*) considering the following characters: standard length (SL) 3-4 times in body depth and 5-5.4 times in head length (HL), head length 2.2-3 times eye diameter, mouth width 0.8-1 times eye diameter.

Meristic characters including lateral line with 44-46 scales; 9½ scale rows between lateral line and dorsal-fin origin; 4½ scale rows between lateral line and anal-fin origin. The dorsal fin with 3 simple (8)-9½ branched rays and anal fin 4 simple 13-(14)½ branched rays, pectoral fin 1 simple 13-14 (16) branched rays and pelvic fin 1-2 simple 8 branched rays.

Our findings have indicated that standard length (SL) 3.14-4.14 times at dorsal-fin origin same as original description. In a similar way, we observed that when compared to the original description, ratio of HL/SL was less 3.75-4.28 and scale numbers in lateral line (44-48) was little more. Our results have shown, however, that scale rows between lateral line and dorsal-fin origin, between lateral line and anal-fin origin, and the numbers of dorsal and anal fin branched rays were the same as Battalgil's description.

Distribution, habitat and Biology: *A. nasreddini* only lives in Akarçay basin (Eber, Akşehir and Karamık lakes; Selevir and Seyitler reservoirs; Kalli, Adıyan and Akşehir streams) and Ilgın Lake basin (Aşağı Çiğil Creek-Ilgın) and Beşgöz system (Sarayönü) (Figure 6).

On sampling and monitoring conducted between April-June 2015, specimens partially migrating to Kalli and Akşehir streams flowing into Eber Lake have been observed. During the examination of 26 samples from Selevir Reservoir and Kalli Creek populations, it has been identified that the population is between the age groups of I and V; individuals between III and IV age group make the majority of the population (84.08%). Selevir Reservoir population starts spawning at second period of June where water temperature reaches 20°C and lasts until mid-July. It has been observed that they migrate to shallow coastal zones where densely weed beds exist for laying eggs. In females, average GSI was 13.66%, egg diameter was 1.06 mm and fecundity was 707 egg/g as they were determined.

A. nasreddini feeds on zooplankton and neuston in lake ecosystems and on benthopelagic in river ecosystems. They mostly feed on zooplankton (Rotifera, mostly Cladocera and Copepoda), amphipods, dipterans larva and pupae, and rarely on plant material. In an experiment conducted in a semi-closed environment, it has been pointed that individuals of this species consumed an important portion of mosquito larvae, and they repress mosquito populations on natural environments (Aldemir & Boşgelmez, 2004).

Negative developments posing a threat to these species habitats (drought, heavy pollution Kalli Stream Şuhut region and Akarçay from Afyonkarahisar municipal waste water and interference to the riverbed as DSİ canals, regulators, and reservoirs) have affected its migration and other vital activities. Therefore, enough population has not been encountered on habitats other than Selevir and Seyitler reservoirs (Table 3).

Conclusions

Based on Kosswig (1954), systematic status of *A. nasreddini* has been given as *A. orontis* until recently (Alp & Balık, 1994; Geldiay & Balık, 1999; Yeğen *et al*., 2007). In our study, Battalgil (1944)'s morphological description has been updated and compared with *A. escherichii* from the closest basin.

Among Anatolian species of *Alburnus*, *A. nasreddini* is the most similar fish to the *A. escherichii* from the geographically close basin

Figure 3. *A. nasreddini* about 103 mm SL, Selevir Reservoir (fixed specimen) (IFC-ESUF 03-0373).

Figure 4. *Alburnus escherichii* about 130 mm SL, Yörükkırka, Porsuk Stream (IFC-ESUF 03-0335).

Figure 5. *Alburnus escherichii* about 178 mm SL, Üstünler Stream (Beyşehir Lake basin) (IFC-ESUF 03-0372).

Sakarya River drainage, both having fewer numbers of lateral line scales 44 (1), 45 (2), 46 (10), 47 (7) and 48 (5) in *A. nasreddini*; 46 (1), 47 (7), 48 (4), 49 (3), 50 (1), 51 (1) and 53 (1) in *A. escherichii*.

A. nasreddini is distinguished from *A. escherichii* by deeper body depth (body deep at dorsal-fin origin 24.14-28.20, mean 26.64, vs. 22.00-26.29, mean 23.92, and body deep at anal-fin origin 20.43-23.28, mean 21.93, vs. 18.16-20.96, mean 19.46), by shorter snout (21.77-28.37, mean 25.54, vs. 25.68-30.67, mean 27.55) and large eye diameter (26.57-34.35, mean 31.22, vs. 24.64-30.61, mean 27.88). It further differs from *A. escherichii* by markedly pointed snout (vs. slightly pointed or rounded) and partly developed ventral keel exposed for 4-5 scales in front of the anus (vs. 2-3 scales) and free margins of lateral scales colourless (vs. with brown line).

The number of scales and gill rakers are based on our material and data in Bogutskaya *et al*. (2000), Özuluğ and Freyhof (2007a, b) and Kottelat and Freyhof (2007); *A. nasreddini* is distinguished from the other Western Anatolian *Alburnus* species by having 14-17 gill rakers (vs. 23-31 in *A. attalus*, 11-13 in *A. baliki*, 27-32 in *A. battalgilae*, 33-39 in *A. carinatus*, 18-21 in *A. demiri*) and 44-48 total scales

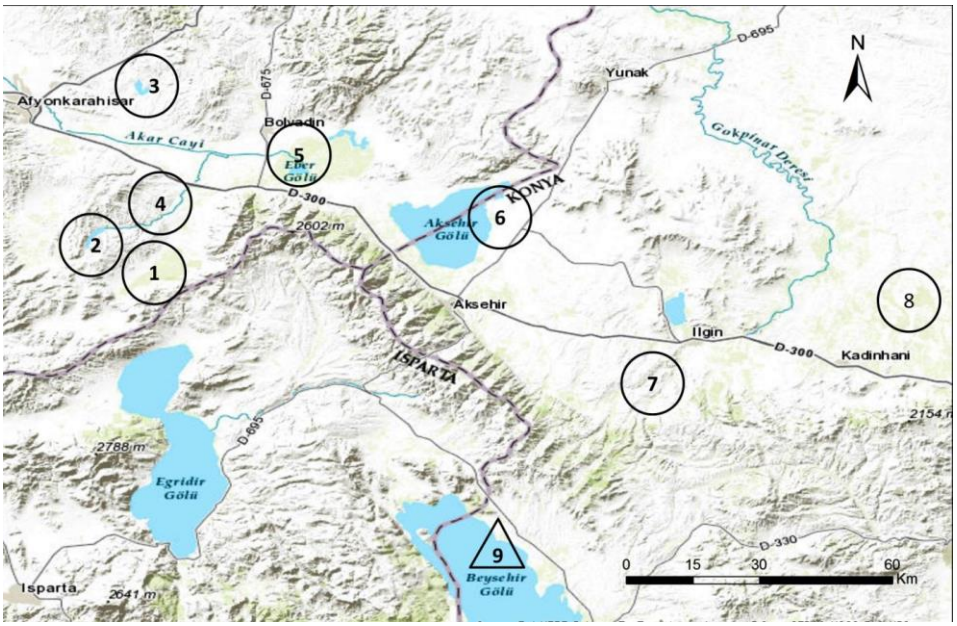

Figure 6. Distribution area of *A. nasreddini* populations: 1. Karamık Lake, 2. Selevir Reservoir, 3. Seyitler Reservoir (only observation), 4. Kalli Creek, 5. Eber Lake (specimen not available), 6. Akşehir Lake, Adıyan and Akşehir streams (specimen not available), 7. Aşağı Çiğil Stream (in Ilgın Lake basin), 8. Beşgözler karstic system (Sarayönü) and 9. *A. escherichii* in Beyşehir Lake and its drainage systems.

Table 3. The distribution area of *A. nasreddini*, and general characteristics of the habitats

Habitats	Relative Populations density	other species	General ecologic properties and/or threats
1. Karamık Lake	low	*Cyprinus carpio, Carassius gibelio Esox lucius, Gambusis holbrooki Astacus leptodactylus*	very dense macrophyte beds, intense degradation products, limnetic zone very narrow, relatively low oxygenation, moderate fishing activity
2. Selevir Reservoir	high	*C. carpio, C. gibelio, Sander lucioperca, Knipowitschia caucasica, Oncorhynchus mykiss, Cobitis simplicispinna, A. leptodactylus*	moderate submerged vegetation, mesotrophic condition, moderate fishing and cages fisheries activity
3. Seyitler Reservoir	medium	*C. carpio, C. gibelio, S. lucioperca, K. caucasica, A. leptodactylus*	moderate submerged vegetation, mesotrophic condition, amateur fishing
4. Kalli Creek	low	*C. carpio, C. gibelio, Capoeta baliki, Squalius recurvirostris, Gobio intermedius, Oxyneomacheilus* cf. *angorae, G. holbrooki*	domestic and septic pollution, river bed manipulation, and flow rate decreasing
5. Eber Lake	rare	*C. carpio, C. gibelio, E. lucius, G. holbrooki, C. simplicispinna, Tinca tinca, A. leptodactylus*	very dense macrophyte beds, intense degradation products, heavy domestic and industrial pollution, anoxic and/or hypoxic conditions, water level decreasing
6. Akşehir Lake, Adıyan and Akşehir streams	rare	*C. carpio* (?)*, *C. gibelio, G. intermedius, S. recurvirostris* (?), *O.* cf. *angorae, E. lucius* (?), *G. holbrooki* *the presence of doubtful	severe drought
7. Aşağı Çiğil Stream (Ilgın Lake basin)	low	*S. recurvirostris, G. intermedius, O.* cf. *angorae*	drought
8. Beşgözler karstic spring (Sarayönü)	low	*C. carpio, C. gibelio, G. intermedius, Cobitis* sp. *Oxynemhacheilus* sp. *S. recurvirostris, E. lucius, G. holbrooki, Aphanius villvocki, O. mykiss*	excessive water withdrawal, fish farming

in lateral line (vs. 52-59 in *A. attalus*, 47-61 in *A. baliki*, 53-61 in *A. battalgilae*, 58-62 in *A. carinatus*). *A. nasreddini* is distinguished from *A. alburnus* (Thrace and Marmara Region of Turkey) by its fewer anal-fin branched rays (12-15, vs. 17-20) and fewer gill rakers (14-17, vs. 16-22)

Our present study has confirmed that *A. nasreddini* is a valid species that distributes in Eber, Akşehir and Ilgın (Çavuşçu) lakes basin; however, *A. escherichii* lives in Beyşehir Lake basin (small rivers flowing into the lake, Çarşamba Chanel, and Apa Reservoir) (Freyhof & Özuluğ, 2009) next to Sakarya River basin and Manavgat Reservoir which are connected to those basins. As it is obvious that *A. escherichii* was brought to Beyşehir Lake by commercial fishermen from Sarıyar Reservoir (Sakarya River basin), it is thought that the existence of these species in Manavgat River is related to natural conditions and it introduced into Manavgat River from Beyşehir Lake basin.

Comparative Material

A. nasreddini: IFC-ESUF 03-0374, 22, 57.79-94.35 mm SL; Afyonkarahisar prov.: Karamık Lake; F. Küçük, S.S. Güçlü, Ö. Erdoğan, 29 June 2015. IFC-ESUF; Konya prov.: Aşağı Çiğil Stream (Ilgın), F. Küçük, İ. Gülle, July 2014. IFC-ESUF 03-0377, 19, 43.23-105.70 mm SL; Konya prov.: Beşgöz Creek-Sarayönü, F. Küçük, İ. Gülle, 19 July 2014.

A. escherichii: IFC-ESUF 03-0335, 14, 46.71-105.02 mm SL; Eskişehir prov.: Porsuk Stream (Yörükkırka Village); F. Küçük, S.S. Güçlü & A.Vişne, 04 September 2012. IFC-ESUF 03-0333, 28, 55.56-100.12 mm SL; Eskişehir prov.: Akin Stream (Kırka); F. Küçük & S.S. Güçlü, 05 September 2012. –IFC-ESUF 03-0372, 2, 106.82-120.16 mm SL; Konya prov.: Üstünler Stream (Beyşehir); F. Küçük & İ. Gülle, 29 June 2014.

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