



Distribution of *Rhodeus amarus* (Bloch, 1782) (Teleostei: Acheilognathidae) in Turkey

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Abstract: The present study aims to reveal the current distribution area of *Rhodeus amarus* in the freshwaters of Turkey. The survey was conducted between 2004-2019 from 56 sampling locations. Also, it was made a detailed literature research. *R. amarus* is distributed in rivers and streams flowing into the Black, Aegean, Marmara, Caspian Sea basins, and some lake basins in Anatolia.

Keywords: European bitterling, freshwater fish, taxonomy.

Rhodeus amarus Türünün (Bloch, 1782) (Teleostei: Acheilognathidae) Türkiye'deki Dağılımı

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Öz: Bu çalışmanın amacı *Rhodeus amarus* türünün Türkiye iç sularındaki güncel dağılımını ortaya çıkarmaktır. Çalışma 2004-2009 yıllarında yürütülmüş ve balık numuneleri 56 farklı lokasyondan toplanmıştır. Ayrıca, detaylı bir literatür araştırması da yapılmıştır. *R. amarus* türü Anadolu'daki bazı göller ve Karadeniz, Ege, Marmara, Hazar Denizi havzalarına dökülen nehir ve akarsularda dağılım gösterir.

Anahtar kelimeler: Acı balık, taksonomi, tatlı su balığı.

INTRODUCTION

Rhodeus amarus was originally described from the Lake Müggelsee, near Köpenick, (Berlin) by Bloch (1782). The European bitterling is the only species which represents the genus *Rhodeus* Agassiz 1880 in Turkey. The members of Acheilognathidae widely distributed from Europe to Asia and comprises more than 81 species (Kottelat & Freyhof, 2007; Esmaeili et al., 2020). The taxonomic status of *R. amarus* was controversial. It was accepted as a synonym of *Rhodeus sericeus* (Pallas, 1776) by some researchers, (e.g. Smith, 1986; Lelek, 1987; Naseka, 1998; Coad, 1998). Mrakovčić et al., (1995) treated *R. sericeus* and *R. amarus* as two distinct valid species, and later authors have followed

this view (e.g. Kottelat, 1997; Bogutskaya & Naseka, 2004; Bektaş et al., 2013; Parin et al., 2014; Li et al., 2017; Bartáková, et al., 2019).

Some studies related to bitterling in Turkey are as follows: Tarkan et al., (2005) studied the life history pattern of *Rhodeus amarus*, in a large drinking-water system from Ömerli Dam Lake-İstanbul. Bektaş et al., (2013) examined the phylogenetic position of the European Bitterling in Turkey. İlhan et al., (2014) conducted the length-weight relationships of *R. amarus* in Turkey. Özuluğ & Saç, (2019) investigated the freshwater fish fauna of İstanbul province and they gave numerous *R. amarus* record. While many

studies have been conducted on the *R. amarus*, none comprehensive research on the distribution of the species has been done. In this study, both a detailed literature review was made and fish were collected from fifty-six different locations, and the distribution area of *R. amarus* was revealed.

MATERIAL AND METHOD

Fish samples were caught by Samus 1000 pulsed DC electro-fishing equipment, cast, and gill-nets from 56 sampling locations (Table 1). After anaesthesia, fish specimens were fixed in 4% formaldehyde solution and transferred to the laboratory, identification follows Kottelat & Freyhof, (2007). Material examined is deposited in: Recep Tayyip Erdogan University Zoology Museum of the Faculty of Fisheries, Rize (FFR). All georeferenced information in Table 1 was given for the first time in this study and the data in Table 2 was provided from the literature. The map (Fig. 1) was created from the coordinates in Table 1-2, and using the Qgis v.3.8.3-Zanzibar software available at <http://diva-gis.org>.

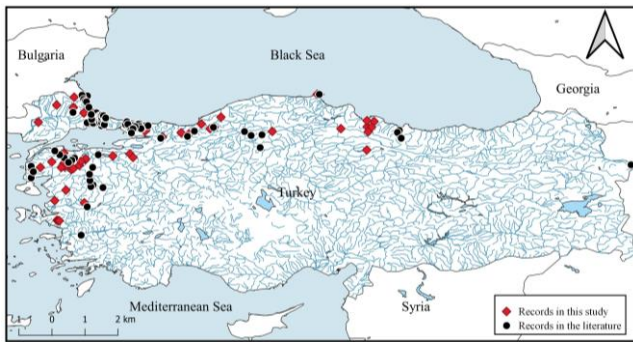


Figure 1. Records of *Rhodeus amarus*, based on materials examined for this study and additional records listed in Table 2 with coordinates.



Figure 2. *Rhodeus amarus*: **a.** about 62 mm SL; inlet water of Tahtalı Dam Lake; **b.** about 55 mm SL; Stream Koca; **c.** about 66 mm SL; Stream Gördeş; **d.** 60 mm SL; Canal B-20., Photo by: Cüneyt Kaya.

Table 1. Geographic information on the locations of *Rhodeus amarus* listed in this study.

	Location description	Sub-drainages	Basin	Sampling Date	Coordinates	
					N	E
1	Ordu Prov., Çatalpınar	Stream Bolaman	Black Sea	07.09.2004	40.885794	37.460327
2	Samsun Prov., Çarşamba	Yeşilırmak River-I	Black Sea	04.10.2015	41.205663	36.726964
3	Samsun Prov., Çarşamba	Stream Abdal	Black Sea	14.07.2007	41.048533	36.515650
4	Samsun Prov., Ayvacık	SuatUğurlu Dam Lake	SuatUğurlu Dam Lake	21.09.2012	41.034285	36.648383
5	Samsun Prov., Ayvacık	HasanUğurlu outlet water	Hasan Uğurlu Dam Lake	23.05.2008	40.893885	36.545776
6	Samsun Prov.,	Stream Gelemen	Black Sea	08.09.2004	41.230286	36.510570
7	Samsun Prov., Havza	Stream Tersakan, Yeşilırmak River	Black Sea	05.09.2014	40.989200	35.717150
8	Sinop Prov., Abalı	Stream Karasu	Black Sea	16.07.2016	42.030332	34.998170
9	Çankırı Prov., Ilgaz	Stream Devrez, Kızılırmak River	Black Sea	30.09.2015	40.904444	33.637500
10	Tokat Prov.,	Yeşilırmak River-II	Black Sea	20.09.2012	40.341467	36.502833
11	Zonguldak Prov., Çaycuma	Stream Çay	Black Sea	05.09.2014	41.337681	32.077031
12	Zonguldak Prov., Alaplı	Stream Alaplı	Black Sea	02.04.2019	41.131200	31.482700
13	Zonguldak, Devrek	Stream Bolu-I	Black Sea	07.11.2016	41.034444	31.876944
14	Zonguldak Prov.,Devrek	Stream Bolu-II	Black Sea	05.09.2014	41.027883	31.848483
15	Bolu Prov., Merkeşler	Stream Bolu-III	Black Sea	26.11.2006	40.989278	31.749767
16	Düzce Prov.,	Stream Büyükmelen	Black Sea	14.07.2016	40.835806	31.110053
17	Kocaeli Prov., Körfez	Stream Koca	Black Sea	19.10.2014	40.948483	29.802867
18	Kocaeli Prov., Körfez	Stream Göksu	Black Sea	19.10.2014	40.916500	29.768500
19	Sakarya Prov., Hendek	A tributary of Büyükmelen	Black Sea	04.09.2014	40.864778	30.868953
20	Sakarya Prov., Serdiven	Lake Sapanca	Lake Sapanca	10.10.2011	40.737785	30.302296
21	İstanbul Prov., Çatalca	Stream Çamaşır	Büyüçekmece Lake	16.08.2005	41.131653	28.509632

Table 1. (Continued).

22	İstanbul Prov., Çatalca	Stream Karamandere	Black Sea	16.08.2005	41.432733	28.138417
23	Tekirdağ Prov., Saray	Stream Bahçe (Istranca)	Black Sea	15.08.2005	41.569167	28.079444
24	Tekirdağ, Saray	Ergene River-I	Aegean Sea	15.08.2005	41.474533	27.920667
25	Kırklareli Prov., Demirköy	Stream Mutlu (Rezve)	Black Sea	20.10.2014	41.942233	27.620233
26	Kırklareli Prov.,	Stream İnce, Ergene River	Aegean Sea	20.10.2014	41.706070	27.090738
27	Kırklareli Prov., Pınarhisar	Stream Büyük-I	Aegean Sea	26.01.2006	41.633698	27.599400
28	Kırklareli Prov., Saray	Stream Kavacı	Aegean Sea	23.04.2004	41.462903	27.918190
29	Kırklareli Prov., Pınarhisar	Stream Büyük-II	Aegean Sea	26.11.2006	41.627183	27.593717
30	Edirne Prov., Akıncılar	Ergene River-II	Aegean Sea	26.11.2006	41.183440	26.534645
31	Çanakkale Prov., Ezine	Stream Akçin	Aegean Sea	27.11.2006	39.759880	26.341532
32	Çanakkale Prov., Bayramiç	Stream (Kara) Menderes	Aegean Sea	27.11.2006	39.816941	26.597774
33	Çanakkale Prov., Çan	Stream Çan	Marmara Sea	25.11.2006	39.983632	26.943353
34	Çanakkale, Prov., Yenice	Stream Koca	Marmara Sea	31.08.2014	39.833467	27.332300
35	Çanakkale Prov., Yenice	Stream Kocaköy	Marmara Sea	02.09.2014	39.941111	27.310000
36	Çanakkale Prov., Yenice	Stream Koca	Marmara Sea	01.09.2014	39.814700	27.229483
37	Çanakkale Prov., Yenice	Stream İnova	Marmara Sea	31.08.2014	40.076470	27.350217
38	Çanakkale Prov., Biga	Stream Çan	Marmara Sea	02.09.2014	40.212967	27.240483
39	Çanakkale Prov., Biga	Stream Hoşap	Marmara Sea	02.09.2014	40.251633	27.309683
40	Çanakkale Prov., Biga	Stream Balıklı	Marmara Sea	30.08.2014	40.104200	27.319883
41	Balıkesir Prov., Balya	Stream Koca	Marmara Sea	30.08.2014	39.752619	27.532773
42	Balıkesir Prov., Balya	Stream Alburak	Marmara Sea	30.08.2014	39.877733	27.779167
43	Balıkesir Prov., Balya	Stream Kocaçay	Marmara Sea	30.08.2014	39.782000	27.596167
44	Balıkesir Prov., Manyas	Stream Sakar	Lake Kuş	29.08.2014	40.049850	27.962383
45	Balıkesir Prov., Manyas	Stream Manyas	Lake Kuş	11.07.2007	40.075467	27.968758
46	Balıkesir Prov., Manyas	Stream Değirmenboğazi	Lake Kuş	29.08.2014	40.000183	27.828383
47	Bursa Prov., Karacabey	Stream Çapraz	Lake Ulubat	29.08.2014	40.200735	28.374556
48	Bursa Prov., Nilüfer	Stream Hasanağa	Hasanağa Dam Lake	29.08.2014	40.161156	28.794459
49	Bursa Prov., Kestel	Drying canal	Lake Gölbaşı	25.06.2015	40.224761	29.314838
50	Bursa Prov., İnegöl	Stream Kara	Marmara Sea	28.11.2004	40.117842	29.408326
51	Manisa Prov., Gölçimarmara	Stream Gördeş	Lake Marmara	16.07.2018	38.742824	27.929674
52	İzmir Prov., Aliğa	Stream Koca	Aegean Sea	15.11.2018	38.810193	27.030065
53	İzmir Prov., Kınık	Stream Karadere, Bskırçay	Aegean Sea	16.07.2018	39.129917	27.372278
54	İzmir Prov., Menderes	Stream Balaban	Tahtalı Dam Lake	15.11.2018	38.213950	27.101505
55	İzmir Prov., Menderes	Stream Den	Tahtalı Dam Lake	14.07.2018	38.199395	27.135946
56	İzmir Prov., Cumaovası	Tahtalı inlet water	Tahtalı Dam Lake	14.07.2018	38.199044	27.170517

RESULTS

Rhodeus amarus has recently been recorded in Aras River, Turkey (Kaya et al., 2020). A comparison the *R. amarus* population from the upper Aras River with recently described *Rhodeus caspius* Esmaeili, Sayyadzadeh, Japoshvili, Eagderi, Abbasi & Mousavi-Sabet, (2020) is needed. Because, the Aras population is geographically close to Lake Urmia and the upper Tigris River where *R. caspius* was described. Furthermore, southeastern Black Sea populations should be compared with *R. colchicus* Bogutskaya & Komlev, (2001) from the rivers in West Transcaucasia, Georgia. This genus should be compared with different populations, which should be reviewed, using both morphological and molecular data, to understand the diversity of the genus. With this study, the distribution area of *R. amarus* has been revealed, and an updated set of European bitterling occurrence data has been documented, showing ranges of distribution.

Distribution and habitat. *Rhodeus amarus* is a small freshwater fish that inhabits lotic (especially lowland rivers and slowing streams) and lentic habitats (Lelek, 1987; Van Damme et al., 2007; Bryja et al., 2010). European Bitterling is distributed in rivers and streams flowing into the Black, Aegean, Marmara Sea basins, also, lakes Ulubat, Sapanca, Marmara, Büyükçekmece, Kuş and Gölbaşı basins. The species is also known from Tahtalı, Hasanağa, Suatugurlu, Hasanağurlu, Ömerli Dam Lake basins (Tarkan

et al., 2005; İlhan et al. 2014; Sarı et al., 2019). Also, it was recently recorded in the Aras River drainage (Kaya et al., 2020) (Figures 2-4).



Figure 3. *Rhodeus amarus*, a. 64 mm SL; Stream (Kara) Menderes; b. 50 mm SL; Ergene River; c. 66 mm SL; Suatugurlu Dam Lake.



Figure 4. *Rhodeus amarus*, **a.** 62 mm SL; Stream Abdal; **b.** 48 mm SL; A tributary of Büyükmelen; **c.** 60 mm SL; Stream Terkos.



Figure 5. Some typical habitat of *Rhodeus amarus*.

Table 2. Previous records of *Rhodeus amarus* in the literature other than listed in Table 1.

References	Description of locality	Coordinates	
		N	E
Tarkan et al., 2005	Stream Ballıca (Ömerli Dam Lake)	41.000556	29.418611
	Ömerli Dam Lake	41.084722	29.421944
	Ozan Stream (Ömerli Dam Lake Basin)	41.051389	29.469167
Sarı et al., 2006	Stream Gönen-I, Balıkesir	40.100000	27.633333
	Stream Gönen-II, Balıkesir	40.033333	27.550000
	Stream Gönen-III, Balıkesir	39.966667	27.450000
	Stream Tuzla, Çanakkale	39.500000	26.316667
	Stream Karamenderes, Çanakkale	39.850000	26.316667
	Stream Koca, Çanakkale	40.197500	27.183333
	Stream Bakçeli, Çanakkale	39.683333	26.383333
	Stream Çınarlı, Çanakkale	40.316667	27.033333
Reichard et al., 2010	Lake Sapanca	40.700000	30.250000
Güçlü et al., 2013	Stream Çine, Büyük Menderes River	37.763364	27.834172
İlhan & Sarı, 2015	Lake Marmara	38.621389	28.016667
	Binmurt Bridge, Sındırgı-Balıkesir	39.204444	28.495278
Öztürk & Küçük, 2017	Sındırgı Bridge, Sındırgı-Balıkesir	39.285000	28.196944
	Cüneyt Bridge, Sındırgı-Balıkesir	39.233333	28.127500
	Bigadiç Bridge, Balıkesir	39.416667	28.100000
	Mahmudiye Köprüsü, Kepsut-Balıkesir	39.606861	28.086722
	Yıldızköy Bridge, Susurluk-Balıkesir	39.816667	28.183333
	Saç & Özüluğ., 2017	Creek Donamandıra	41.314150
Creek Şeytan		41.417500	28.138450
Creek Binkılıç		41.399010	28.193660
Creek Karamandere		41.379200	28.296100
Creek Karacaköy		41.399460	28.383520
Özüluğ & Saç., 2019	Pond Değirmenköy, İstanbul	41.168219	28.013197
	Stream Kula, İstanbul	41.156453	28.199108
	Stream Akören, İstanbul	41.233824	28.357013
	Stream Akören, İstanbul	41.233824	28.357013
	Pond Çakıl, İstanbul	41.077974	28.450129
	Stream İncegiz, İstanbul	41.181198	28.399491
	Stream Gökçeali, İstanbul	41.191162	28.450287
	Stream İzzettin, İstanbul	41.209173	28.529896
	Stream Binkılıç, İstanbul	41.398415	28.192050
	Stream Şeytan, İstanbul	41.417656	28.138615
	Stream Danamandıra, İstanbul	41.329032	28.263689
	Stream Yaylacık, İstanbul	41.357333	28.227965
	Stream Çayırdere, İstanbul	41.271881	28.152864
	Stream Karamandere, İstanbul	41.469393	28.297715
	Stream Belgrat, İstanbul	41.377367	28.384866
	Stream Çiftlikköy, İstanbul	41.365041	28.402299
	Stream Çiftlikköy, İstanbul	41.336464	28.417534
	Stream Kalfaköy, İstanbul	41.288315	28.444674
	Stream Başak, İstanbul	41.334384	28.452862
	Stream Ormanlı, İstanbul	41.400224	28.470836
Stream Ormanlı, İstanbul	41.400224	28.470836	
Lake Durusu, İstanbul	41.317620	28.534114	

Table 2. (Continued).

	Lake Durusu, İstanbul	41.381534	28.511841
	Stream Göksu, İstanbul	41.077455	29.777119
	Stream Sungurlu, İstanbul	41.079284	29.863491
	Stream Karaman, İstanbul	41.145424	29.592317
	Stream Türknil, İstanbul	41.150584	29.593545
	Stream Yeşildere, İstanbul	41.124165	29.567502
	Stream Teke, İstanbul	41.048887	29.622227
	Stream Değirmençayırı, İstanbul	40.987657	29.667403
	Stream Yaka, İstanbul	40.990823	29.649617
Özuluğ & Saç., 2019	Lake Büyükçekmece, İstanbul	41.109843	28.537627
	Lake Durusu, İstanbul	41.295909	28.574428
	Lake Durusu, İstanbul	41.311591	28.579619
	Stream Polonez, İstanbul	41.116409	29.182389
	Stream Kömürlük, İstanbul	41.084821	29.422119
	Stream Ozan, İstanbul	41.050974	29.470373
	Stream Yeniçiflik, İstanbul	41.199207	29.224038
	Stream Cumhuriyet, İstanbul	41.123793	29.251744
	Stream Kurna, İstanbul	40.953616	29.346270
	Stream Ballica, İstanbul	40.993331	29.413334
	Stream Ballica, İstanbul	40.983290	29.406356
	Stream Tuzla, İstanbul	40.859167	29.359446
Sarı et al., 2019	Stream Rezve (Mutlu), Kırklareli	41.981389	28.025833
	Stream Rezve (Mutlu), Kırklareli	42.002500	27.860000
	Stream Madra Kırklareli	41.879444	27.908889
	Stream Bulanık, Kırklareli	41.820833	27.954444
	Lake Saka, Kırklareli	41.801111	27.995278
	Stream Pabuç, Kırklareli	41.636944	28.069722
Batakova et al., 2019	Stream Bolu, Zonguldak	41.028694	31.848444
	Stream Sütlice (Ahmetbey), Kırklareli	41.483194	27.585917
	Stream Karamanenderes, İstanbul	41.417806	28.138556
	Stream Balıklı, Çanakkale	40.105194	27.319639
	Stream Capraz at Karacabey	40.197250	28.352222
Güçlü, 2020	Stream Büyük Melen (Düzce)	40.914139	31.270983
	Lake Efteni (Düzce)	40.756176	31.060851
Yoğurtçuoğlu et al., 2020	Sabanözü Creek near Bulgurcu	40.416667	33.266667
	Hacılar Creek south to Karamustafa	40.781667	32.993333
	Çerkes River 3 km west to Akbas	40.901667	32.791667
	Karasu River, Sinop	42.028333	35.061667
	Stream Devrez, Çankırı	40.803333	33.321667
Kaya et al., 2020	Canal B-20, Aras River, Iğdır	39.893600	44.525600
Saygun, 2021	Stream Bolaman-I, Ordu	40.939722	37.492222
	Stream Bolaman-II, Ordu	40.755833	37.510556
	Stream Karakoyun, Ordu	40.874444	37.433611
	A tributary of Bolaman, Ordu	40.700278	37.549444
Uğurlu & Polat, 2007	Çakmak Baraj Gölü, Samsun		Records without coordinates
Özuluğ et al., 2007	Stream Mahmudiye, Lake Sapanca		
	Stream Maşukiye, Lake Sapanca		
Özuluğ, 2008	Streams Yıldız I-II, Lake Durusu		
	Lake Durusu		
	Stream Darboğaz, Lake Durusu		
	Stream Çiftlikköy, Lake Durusu		
İlhan & Balık, 2008	Stream Batbaşı, Western Black Sea Basin		
	Stream Karasu, Western Black Sea Basin		
	Stream Maden, Western Black Sea Basin		
	Stream Salı, Western Black Sea Basin		
	Stream Karaköse, Western Black Sea Basin		
Bektaş et al., 2013	Stream Abdal, Black Sea Basin		
	Stream Koca, Marmara Sea basin		
	Stream Karaman, Lake Durusu		
	Stream Kavacık, Black Sea Basin		
İlhan et al., 2014	Western Black Sea Basin		
	Gediz River drainage		
	Küçük Menderes River drainage		
	Northern Egean Sea Basin		
	Marmara Sea Basin		
İlhan et al., 2014	Meriç River drainage		
	Sakarya River drainage		
	Susurluk drainage		
	Yeşilirmak River drainage		
Güçlü & Küçük., 2015	Yurtbaşı Village, Kula-Manisa		
	Halıtpaşa Bridge, Saruhanlı-Manisa		
	Hacıveliler Village, Gölarmara-Manisa		
	Akpınar Spring, Gölarmara-Manisa		
Saygun et al., 2017	River Ilca, Ordu		
Saygun et al., 2018	Streams Terme and Terice, Samsun		
Saruhan & Kırankaya, 2019	Stream Asar, a tributary of Melen River		
Gaygusuz et al., 2019	Stream Darlık and tributaries, İstanbul		
Benzer & Gül, 2020	Stream Dinsiz, Sakarya River		
Çiçek et al., 2020	Northwestern Anatolia		
İlhan et al., 2020	Tributaries of Bakırçay		

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