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Original research

Fish species composition and length-weight relationships in Onaç Creek (Burdur-Turkey)

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Abstract: This study describes the fish species composition and their length-weight relationships from Onaç Creek (Burdur-Turkey). A total of 498 individuals representing five fish species belongs to three families were caught by electrofishing techniques from May 2013 to June 2015. *Cyprinidae* was the most abundant family in terms of species number. *Cyprinidae* species comprised 350 (70.28%) of 498 specimens. Non indigenous fish species represents the highest abundance (98%). Topmouth gudgeon, *Pseudorasbora parva* was the most frequently captured species (43.57%), followed by eastern mosquitofish, *Gambusia holbrooki* (28.92%) and Prussian carp, *Carassius gibelio* (25.5%). The length-weight relationships for Prussian carp, Topmouth gudgeon and Eastern mosquitofish populations were estimated as $W= 0.0097\ TL^{3.187}$, $W = 0.0061\ TL^{3.26}$ and $W = 0.0083\ TL^{2.995}$, respectively.

Keywords: Non indigenous, invasive, dominancy, threats, endemic

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Introduction

Anatolia is home to a large number of endemic fish species (Geldiay and Balık, 2007; Çiçek et al., 2015). Many of the endemic fishes in Anatolia are now directly under several threats, which are mostly induced by human activities (Fricke et al., 2007). Anthropogenic movements of invasive species are considered one of the main threats to aquatic biodiversity. Many papers have reviewed status and distribution of alien species in the inland waters of Turkey (İnnal and Erk'akan, 2006; Çetinkaya, 2006; Balık and Ustaoğlu, 2006).

The Lakes District of Turkey (located at southern Mediterranean region) is characterized by great diversity of natural ecosystems. Compared to the other parts of Turkey, this region has relatively richer endemic aquatic fauna because of it's habitat richness coming from geographical process (Balık, 1995; Demirsoy, 2002).

The presence of alien fish in Lakes district of Turkey has been recorded by Yeğen et al. (2006), Küçük et al. (2006), Özkök et al. (2007), Çınar et al. (2007), Küçük et al. (2012), İlhan et al. (2014), Küçük et al. (2016), Güçlü et al. (2017), Apaydın-Yağcı et al. (2018). Approximately ten species of exotic or translocated fish species have been introduced into Lakes District of Turkey. The following *species* have produced self-sustained populations and widespread: *Carassius gibelio* (Bloch, 1782), *Pseudorasbora parva* (Temminck and Schlegel, 1846), *Gambusia holbrooki* Girard, 1859. Biological properties are lacking for Onaç Creek fishes. This study concerns an investigation of the population structures and length-weight relationships of *C. gibelio*, *P. parva* and *G. holbrooki* living in Onaç Creek, Burdur, Turkey.

Material and Methods

Fish specimens were caught monthly interval with electrofishing equipment from three different locations of

Onaç Creek (Burdur) between May 2013 and June 2015. The Onaç Creek flows from the nothern part of the Kestel Mountain, 1300 meters high and fed by small springs and melted snow water. It occupies Bucak plain and pour into the temporary Kestel Lake. The decline of the rains led to reduce the water of Onaç Creek and it completely dries in some years.

Fish specimens were collected and identified species level according to Freyhof and Özuluğ (2006) and Kottelat and Freyhof (2007). The abundance of species was according to Şişli (1996). Abundance % = [Ni/Nt] x 100, (Ni: The number of specimens of the species; Nt: The total number of specimens). Fish samples were immediately transported to the laboratory. Size (total length cm TL; precision 1 mm) and weight (total weight W to nearest 0.1 g) were calculated. Length-weight relationship was calculated using the equation $W = aL^b$ (Pauly, 1984), where *a* is a coefficient related to body form and *b* is an exponent indicating isometric growth when equal to 3. The significance of the b value for each species was tested by t-test. The degree of association between the variables was computed by the determination coefficient, r^2.

Results

A total of 498 individuals representing five natives and non native fish species was caught throughout the study. Fish specimens belonging to three families (Poecilidae, Cyprinodontidae and Cyprinidae). *P. parva* was the most frequently captured species, followed by *G. holbrooki* and *C. gibelio*. Two native species (*Aphanius* sp. and *Pseudophoxinus ninae*) were sampled in small percentages (2 %).

Fish assemblage composition (species numbers, abundance and status) in Onaç Creek is given in Table 1. Length and weight frequency distributions and length-weight relationships are shown in Figure 1. Total length and weight for specimens of *P. parva* ranged from 2.8 to 6.7 cm and 0.143 to 2.9 g, respectivly. Among all individuals, 53.92% were in the size range of 4.0-5.2 cm, 23.50% were smaller than 4 cm, and 22.58% were longer than 5.2 cm. Length-weight relationships were calculated as $W = 0.0061L^{3.26}$ (r^2=0.92) by using the data of 217 *P. parva* specimens.

The specimens of *G. holbrooki* ranged from 0.7 to 4.9 cm in total length and 0.003 to 1.253 g in total weight. The total length of 86.80% of the total sampled speciemens were range of 1.4-3.5 cm, 3.47% were smaller than 1.4 cm, and 9.72% were longer than 3.5cm. Length-weight relationships were estimated as $W = 0.0083L^{2.9956}$ (r^2=0.96) by using 144 specimens.

Total length and weight of the sampled specimens of *C. gibelio* ranged from 3.4 to 27.9 cm and from 0.5 to 470.4 g, respectively. Among all sampled specimens, 76.38% were in the size range of 11-23 cm, 3.94% were smaller than 11 cm, and 19.69% were longer than 23 cm. Length-weight relationships were found to be $W = 0.0097L^{3.1874}$ (r^2=0.99) from 127 specimens.

Discussion

Fishes in the Onaç Creek have been categorized as native and alien species. The alien species, with three species, represented the highest abundance (98 %). High abundance of alien species in Onaç Creek demonstrates antropogenical intervention. *Aphanius sp.* and *P. ninae* are endemic to Anatolian fish fauna and both have an extremely limited distribution. The Onaç Creek is also type locality of *P. ninae* (Freyhof and Özuluğ, 2006). It has been assessed as Critically Endangered (Freyhof, 2014). They are under considerable pressure from a range of anthropogenic activities as other native species.

Table 1. Fish assemblage composition (species, density and status)

Species	Common name	Family	Status	N	N%
Pseudorasbora parva	Topmouth gudgeon	Cyprinidae	Alien	217	43.6
Gambusia holbrooki	Eastern mosquitofish	Poecilidae	Alien	144	28.9
Carassius gibelio	Prussian Carp	Cyprinidae	Alien	127	25.5
Pseudophoxinus ninae	Onaç Spring minnow	Cyprinidae	Endemic	6	1.2
Aphanius sp.	Killifish	Cyprinodontidae	Endemic	4	0.8
Total				498	100

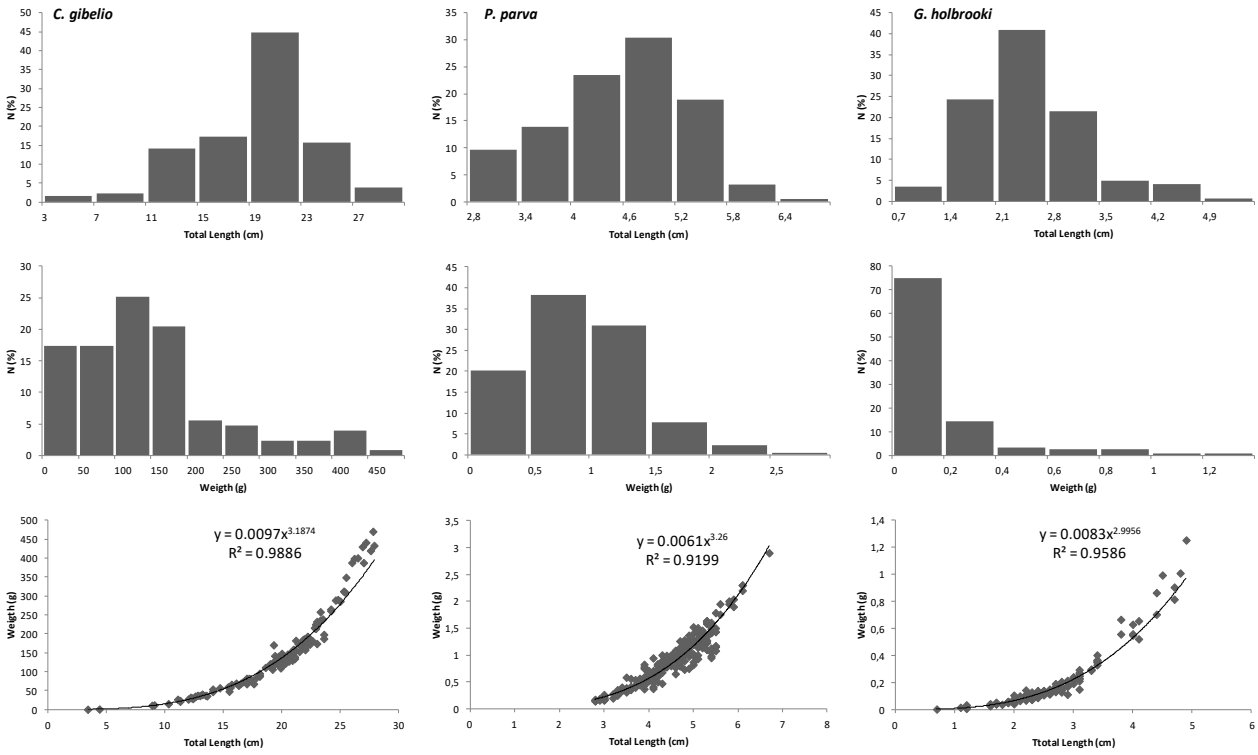

Figure 1. Length and weight frequency distributions and length-weight relationships for *Carassius gibelio, Pseudorasbora parva* and *Gambusia holbrooki*

Table 2. Summary of estimated length weight parameters for *Carassius gibelio, Pseudorasbora parva* and *Gambusia holbrooki.* (TL: Total Length SL: Standart Length FL: Fork Length)

n	L type	L(cm) min-max	W (g) min-max	b	Locality	Author
				Gambusia holbrooki		
224	TL	1.0-4.0	0.01-0.70	2.56	Seyhan Dam Lake	Alagöz Ergüden and Ergüden (2008)
215	TL	1.0- 3.9	*	2.61	Seyhan Dam Lake	Alagöz Ergüden and Göksu (2009)
58	SL	1.4-3.5	*	2.68	Sapanca Lake	Tarkan et al. (2009)
1582	TL	1.0-5.7	*	2.927	Seyhan Dam Lake	Alagöz Ergüden (2012)
5	TL	2.60- 3.9	0.20-0.80	2.945	Marmara Lake	İlhan and Sarı (2015)
909	TL	1.64-4.31	*	2.952	Lake Pamvotis	Gkenas et al.(2012)
25	TL	1.56-3.065	*	2.986	Sirzar River	Eagderi and Radkhah (2015)
144	**TL**	**0.7-4.9**	**0.003-1.253**	**2.996**	**Onaç Creek**	**Present Study**
35	TL	2.38-4.05	*	3.048	Iran	Esmaeili and Ebrahimi (2006)
50	TL	2.25-3.66	*	3.086	Gamasiab River	Eagderi and Radkhah (2015)
4	TL	2.3-2.9	*	3.158	Porto Logos	Koutrakis and Tsikliras (2003)
162	?	1.15-5.8	0.01-2.62	3.168	Murray-Darling River System	Llewellyn (2011)
705	TL	1.3-5.5	0.02-2.31	3.17	Fethiye-Akgöl	Öztürk and İkiz (2004)
639	TL	1.3-5.8	0.02-5.83	3.27	Ortaca	Öztürk and İkiz (2004)
27	TL	1.4-4.41	*	3.31	Neretva Estuary	Dulcic and Glamuzina (2006)
60	FL	1.9 -4.9	*	3.37	Segura River tributaries	Andreu Soler et al. (2006)
682	TL	1.7-5.5	0.06-2.58	3.37	Dalaman	Öztürk and İkiz (2004)
671	TL	1.0-5.1	*	3.382	Rihios Estuary	Koutrakis and Tsikliras (2003)
15	TL	3.2-4.7	*	3.42	Büyükçekmece Dam Lake	Tarkan et al. (2006)
19	TL	2.0-4.4	*	3.49	Ömerli Dam Lake	Tarkan et al. (2006)
57	FL	2.0 -5.7	*	3.59	Segura River	Andreu Soler et al. (2006)
43	TL	2.57-5.53	*	3.763	Pond in Kashmar	Eagderi and Radkhah (2015)
119	FL	2.2 -5.7	*	3.81	Segura River reservoirs	Andreu Soler et al. (2006)

Table 2. continue

				Pseudorasbora parva		
76	TL	4.9-12.0	*	2.9	Hunan H. (China)	Xie et al. (2015)
116	TL	5.20-11.0	1.60-14.60	2.929	Marmara Lake	İlhan and Sarı (2015)
20	TL	5.46-8.37	1.7-6.6	3	İli River (China)	Sui et al. (2015)
33	TL	4.58-7.50	*	3.01	Iran	Esmaeili and Ebrahimi (2006)
141	TL	3.5-9.7	*	3.02	Tarim River (China)	Huo et al. (2012)
1329	FL	2.5-11.8	*	3.032	UK	Britton and Davies (2007)
36	TL	5.0-9.8	*	3.06	Saemangeum Reservoir (S.Korea)	Kim et al. (2015)
162	SL	2.9-9.5	*	3.08	Chishui	Liu et al. (2014)
373	TL	2.31-9.91	0.07-10.0	3.09	Lhasa R.B. (China)	Fan et al. (2015)
2674	TL	1.7-11.9	*	3.09	Erhai Lake (China)	Tang et al. (2013)
8	TL	4.0-6.6	*	3.091	Ergis River (China)	Huo et al. (2011)
30	SL	3.5-7.9	*	3.12	Tian –e-zhou	Wang et al. (2012)
25	TL	3.1-7.5	0.39-4.92	3.15	Zarrineh (Iran)	Radkhah and Eagderi (2015)
7815	TL	1.9-12.5	*	3.204	Flanders (Belgium)	Verreycken et al. (2011)
217	**TL**	**2.8-6.7**	**0.143-2.9**	**3.26**	**Onaç Creek**	**Present Study**
3368	TL	1.8-9.6	*	3.32	Hirfanlı Reservoir	Kırankaya et al. (2014)
30	TL	3.0-7.2	*	3.37	Sirwan River (Iran)	Hasankhani et al. (2014)
435	TL	5.1-12.0	*	3.55	Strymon River (Greece)	Petriki et al. (2011)
				Carassius gibelio		
317	TL	10.7-31.0	26-450	2.571	Seyhan River	Alagöz Ergüden (2015a)
160	TL	11-29.30	40.10-412.9	2.65	Seyhan Dam Lake	Alagöz Ergüden (2015b)
344	FL	5.6-26.8	3.8 -597	2.80(♀♀) 3.05(♂♂)	Gelingüllü Dam Lake	Kırankaya and Ekmekçi (2013)
600	TL	21.9-37.0	*	2.81	Chimaditis Lake	Leonardos et al. (2008)
144	TL	12.2-39.5	26.31-445.5	2.856	Kızılırmak River Basin	Sungur Birecikligil et al. (2016)
314	TL	13.0-35.0	50-900	2.866	Danube River	Gheorghe et al.(2012)
2325	FL	9.7-25.5	23.6-269	2.87	Buldan Dam Lake	Sarı et al. (2008)
95	TL	11.3-35.5	*	2.88	Anzali Wetland	Moradinasab et al. (2012)
480	TL	23.0–31.4	150.88-622.02	2.886(♀♀) 2.981(♂♂)	İkizcetepeler Dam Lake	Erdoğan et al. (2014)
149	FL	14.8-32.5	43.1-807.3	2.94	Seyitler Reservoir	Bulut et al. (2013)
143	TL	12.9-32.3	*	2.945	Volvi	Bobori (2010)
2213	TL	6.80-27.50	4.90-372.20	2.974	Marmara Lake	İlhan and Sarı (2015)
173	FL	16.9-30.0	125-730	2.978	Bafra Fish Lake	Bostancı et al. (2007)
93	TL	24.6-37.5	281.9-870	3.04	Ain Zada Reservoir	Mimeche and Biche (2015)
205	TL	8.4-30.7	*	3.059	Doirani	Bobori (2010)
102	TL	8.2-25.2	*	3.11	Volvi Lake	Kleandhitis et al. (1999)
128	TL	10.3-30.5	25-607	3.114	Aksu River	İnnal (2012)
3114	FL	7.8-32.2	5-829	3.125	İznik Lake	Uysal et al. (2015)
1717	FL	7.5-33.3	8.0-1073	3.128	Eğirdir Lake	Özkök et al. (2007)
487	FL	4.4-31.4	1.44-774.4	3.134	Büyükçekmece Dam Lake	Saç and Okgerman (2015)
155	FL	13.4-26.5	58-550	3.149	Ladik Dam Lake	Yazıcıoğlu et al. (2013)
616	FL	9.0-33.0		3.152	Eğirdir Lake	Balık et al. (2004)
730	TL	3-35.7	*	3.18	Ömerli Dam Lake	Tarkan et al. (2006)
*	TL	1.8-46.6	*	3.183	Flemnish inland waters	Verreycken et al. (2011)
482	FL	7.1-27.4	6.0-495	3.186	Beyşehir Lake	Çınar et al. (2007)
49	TL	8.3-33.5	*	3.187	Mikri Prespa	Bobori (2010)
127	**TL**	**3.4-27.9**	**0.5-470.4**	**3.187**	**Onaç Creek**	**Present Study**
363	TL	5.2-30.2	*	3.25	İznik Lake	Tarkan et al. (2006)
15	TL	37.5-42.3	*	4.3001	Vransko Lake	Treer et al. (2011)

One of the main threats to its environment (Onaç Creek) is the introduction of the non native fish species [*P. parva*, *C. gibelio* and *G. holbrooki*] all of them are invasive. The ecology of native aquatic systems in Lakes District of Turkey has changed considerably in the last decade due to human activities, which have resulted in decreased water quality and quantity (pers. comm. with local authorities). Date and agent of first introduction of

these alien fish species in Onaç Creek are unknown. *C. gibelio, P. parva* and *G. holbrooki* are continuing to steadily increase in abundance, and distribution in the lakes district of Turkey (İnnal D., pers. Observation; Yeğen et al., 2006; Küçük et al., 2009). The extensive geographic distribution and the range of habitats occupied by these invasive species suggest that their wide physiological tolerance. Strong competitive impacts of non-indigenous fishes on native species have been shown in freshwater systems (Özuluğ et al. 2005; Şaşı and Balık, 2003). Subsequent decline of many indigenous fishes was reported from one of the important lake system (Lake Eğirdir) of this region (Küçük et al., 2009).

Another potential risk factor is drought out which alter the normal river flow and may restrict the movement of the fish along the natural creek channel. In some periods Algae explosions have been observed. During these periods some *Aphanius sp.* and *P. ninae* individuals died. These deaths are thought to be caused by toxins from algae.

The length-weight relationships of three fish species belonging to two families were estimated. Comparison of length-weight relationships parameters of species between the present study and previous studies is shown in Table 2. In this study, the b value of the three species remained within the expected range of 2.5-3.5 (Froese, 2006). b value of *P. parva* (95 % confidance intervals 3.2473-3.2806; $p<0.001$) and *C. gibelio* (95 % confidance intervals 3.1824-3.1953; $p<0.001$) were significantly different from 3 and this indicate showed positively allometric growth, whereas *G. holbrooki* (95 % confidance intervals 2.9269-3.1285; $p>0.05$) exhibited isometric growth. The slope b value of the LWR equations showed great variations from one population to another within the same species (Table 2). These variations in length-weight relationships could be caused by sampling and preservation protocols, environmental factors, food availability, diets, genetic factors, gonad maturities, sexes, parasitisms, seasons and other interspecific factors (Tesch, 1971; Wootton, 1998).

In conclusion, this study provides some basic information about three invasive fish species and is thought to be useful for future studies. The role of invasive fish species in the inland water systems of Turkey and their effects on local populations need to be the subject of future research.

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