

## Abstract

Biological invasions have caused considerable disruption to native ecosystems throughout the world through predation, habitat alteration, competition and hybridisation with native species and introduction of diseases or parasites. Species of the genus *Carassius* [*C. auratus* (Linnaeus, 1758), *C. carassius* (Linnaeus, 1758) and *C. gibelio* (Bloch, 1782)] were transported to numerous inland water bodies throughout Turkey. Species are now considered a threat factor for native species. The purpose of this study is to review the current distribution and ecological impacts of species in the inland waters of Turkey.

## Keywords

*Carassius carassius*, *C. auratus*, *C. gibelio*, distribution, ecological impacts, Turkey

## Distribution and impacts of *Carassius* species (Cyprinidae) in Turkey: a review

Deniz INNAL

### Introduction, Hypotheses and Problems for Management

In Europe, three species of the genus *Carassius* Nilsson 1832, are known; the goldfish, *Carassius auratus* (Linnaeus, 1758), the crucian carp, *Carassius carassius* (Linnaeus, 1758) and the prusian (gibel) carp, *Carassius gibelio* (Bloch, 1782) (Ozulug et al. 2004).

Whereas *C. carassius* is native to Turkey, the other two species of the genus *Carassius* were introduced to inland waters of Turkey. Date and agent of first introduction of species are unknown. Species of the genus *Carassius* were transported to numerous inland water bodies throughout Turkey perhaps because of the physical similarity of the species to the native common carp (*Cyprinus carpio* Linnaeus, 1758). As a result of mis-identification, the expansion of species were not noticed. These species are now common in natural habitats, altered waters, park and garden ponds in various parts of Turkey (Balık & Ustaoglu 2006; Cetinkaya 2006;;Innal & Erk'akan 2006).

A total of 25 alien fish

species have been introduced in Turkey as eggs, fry or fingerlings for different purposes over the last five decades. Some of these fish have been used only in closed systems while others have been released into open inland waters throughout the country (Innal & Erk'akan 2006). Freshwater fish introductions may result in impacts as a result of one or many undesirable characteristics, including: competition, habitat alteration, parasitism, predation, hybridisation, alteration of habitat quality and/or ecosystem function, host of pests or parasites (Copp et al. 2005).

Introduction of fish species in Turkey, like elsewhere in the world, has had both positive and negative implications. But the impact of most introductions of fishes is still unknown. Abundance and distribution of *Carassius* species in Turkey continuous to increase steadily, and are now considered a threat factor for native fish species.

The purpose of this study is to investigate risks of anthropochor dispersal of the three species of *Carassius* genus in the inland waters of Turkey.

## Materials and Methods

The report was prepared using the reviews of published literature, reports and working papers about distribution and biology of *Carassius* species (*C. auratus*, *C. carassius* and *C. gibelio*) in the inland water systems of Turkey. For each species, information included range (including natural and altered aquatic systems) and impacts to aquatic ecosystems.

## Results and Discussion

### Distribution of species

Distribution of *C. auratus*, *C. carassius* and *C. gibelio* in the inland waters of Turkey are given in Table 1. Aspect and distribution maps of *C. auratus*, *C. carassius* and *C. gibelio* in the inland waters of Turkey are given in Figures 1 to 3.

*C. auratus*, *C. carassius*, *C. gibelio* were recorded from different water bodies (including natural and altered aquatic systems). Species live and reproduce at a wide range of habitat types and appear tolerant to different environmental conditions; *C. gibelio* is the most distributed fish species of genus in Turkey with up to 77 water bodies invaded (Table 1). Recent interest in exotic fish species for aquaculture and fish stocking programmes raise the possibility of future introductions of *Carassius* species.

### Impacts to aquatic ecosystems

Ecological status and some risk parameters of species are given in Table 2.

The use and value of *Carassius* species in Turkey is unknown. *Carassius* species are undocumented in the live food fish industry, methods for its preparation and consumption are unknown.

Species were originally introduced in several sources for the course of common carp stocking. The genus *Carassius* members are able to live and reproduce at a wide range of temperature degrees and oxygen levels in Turkey. In waters where species are stocked, the naturalized populations reproduce readily.

Species of *Carassius* genus reproduce successfully under natural conditions. *C. gibelio* easily becomes one of the dominant species in stagnant and slowrunning waters (Paulovits et al. 1998). Approximately 500-600 individuals of *C. gibelio* were intentionally introduced from Kayalı Dam Lake (Kırklareli-Thrace) into the Omerli Reservoir by a fisherman. *C. gibelio* has become dominant fish species after its introduction to this reservoir (Ozulug et al. 2005a, b). A similar situation was reported from Büyükcekmece Dam Lake (Ozulug et

## Resumen

Las invasiones biológicas han causado considerable disrupciones a los ecosistemas nativos de todo el Mundo mediante la predación, alteración del hábitat, la competencia e hibridación y por la introducción de enfermedades o parásitos. Las especies del género *Carassius* [*C. auratus* (Linnaeus, 1758), *C. carassius* (Linnaeus, 1758) and *C. gibelio* (Bloch, 1782)] han sido inroducidas en numerosos cuerpos de agua por toda Turquía. Estas especies son ahora consideradas un factor de amenaza para las especies autóctonas. En este estudio se revisa la distribución actual y los impactos ecológicos de estas tres especies en aguas continentales de Turquía.

### Palabras clave

*Carassius carassius*, *C. auratus*, *C. gibelio*, distribución, impactos ecológicos, Turquía

Localities	City	Types of ecosystems					Species			
		Stream-Creek	River	Natural lake	Lagoon	Reservoir -Pond	<i>C. auratus</i>	<i>C. carassius</i>	<i>C. gibelio</i>	<i>Carassius sp</i>
İkizcetepeler	Balıkesir					x		x		
Kadıköy	Edirne					x				x
Karaboğaz	Samsun				x				x	
Karacaören I	Isparta					x	x	x		
Karademir	Tekirdağ					x				x
Karagöl	İzmir			x			x			
Karataş	Burdur			x				x		
Karın	Antalya			x			x			
Kars	Kars	x						x		
Kavaklı	Çanakkale	x							x	
Kayaboğazı	Kütahya					x		x		
Kayalı	Kırklareli					x			x	
Keban	Elazığ					x	x			
Kemer	Aydın					x			x	
Kepez I	Antalya					x		x		
Kınıklı	Tekirdağ	x							x	
Kızılisar	Uşak					x	x		x	
Kızılırmak	Kayseri		x				x			
Kızılırmak	Samsun		x						x	
Kovada	Isparta			x				x		
Köprüçay	Antalya		x				x	x	x	
Kunduzlar	Eskişehir					x			x	
Kuşdemir	Uşak					x	x		x	
Küçük Akgöl	Adapazarı			x				x		
Liman	Samsun				x				x	
Manavgat	Antalya					x	x			
Manyas	Balıkesir			x					x	
Marmara	Manisa			x			x	x	x	
Meriç	Edirne		x						x	
Mert	Samsun	x							x	
Mesudiye	Uşak					x			x	
Milic	Samsun	x							x	
Muhsinli	Sinop					x		x		
Mumcular	Muğla					x		x		
Nazik	Van			x				x		
Nisa	Sinop					x	x	x		
Oymapınar	Antalya					x	x			
Ömerli	İstanbul					x			x	
Pamuklu	Edirne				x			x		
Saka	Kırklareli			x					x	
Sapanca	Adapazarı			x				x	x	
Sarıcaali	Kırklareli					x			x	
Selevir	Afyon					x		x		
Seyhan	Adana					x			x	
Seyitler	Afyon					x			x	
Simenit	Samsun				x				x	
Suat Ugurlu	Samsun					x			x	
Sultanköy	Edirne					x				x
Süloğlu	Edirne					x				x
Takmak I-II	Uşak					x	x		x	
Taşkısığı	Adapazarı			x				x		
Tatlı	Samsun				x				x	

Table 1. Distribution of *C. auratus*, *C. carassius* and *C. gibelio* in the inland waters of Turkey

Localities	City	Types of ecosystems					Species			
		Stream-Creek	River	Natural lake	Lagoon	Reservoir-Pond	<i>C. auratus</i>	<i>C. carassius</i>	<i>C. gibelio</i>	<i>Carassius sp</i>
Terme	Samsun	x							x	
Topçam	Aydın					x			x	
Tortum	Erzurum			x						x
Tunca	Edirne		x				x		x	
Ula	Muğla			x			x		x	
Uluabat	Bursa			x				x	x	
Uzungöl	Samsun				x				x	
Üçpınar	Uşak					x	x		x	
Yarseli	Hatay					x		x		
Yayla	Denizli			x					x	
Yedigöller	Kütahya					x		x		
Yenice	Uşak					x			x	
Yeniçağa	Bolu			x				x		
Yeşilkavak	Uşak					x			x	
Yurtluk	Samsun	x							x	
Zamanlı	Kayseri	x						x		

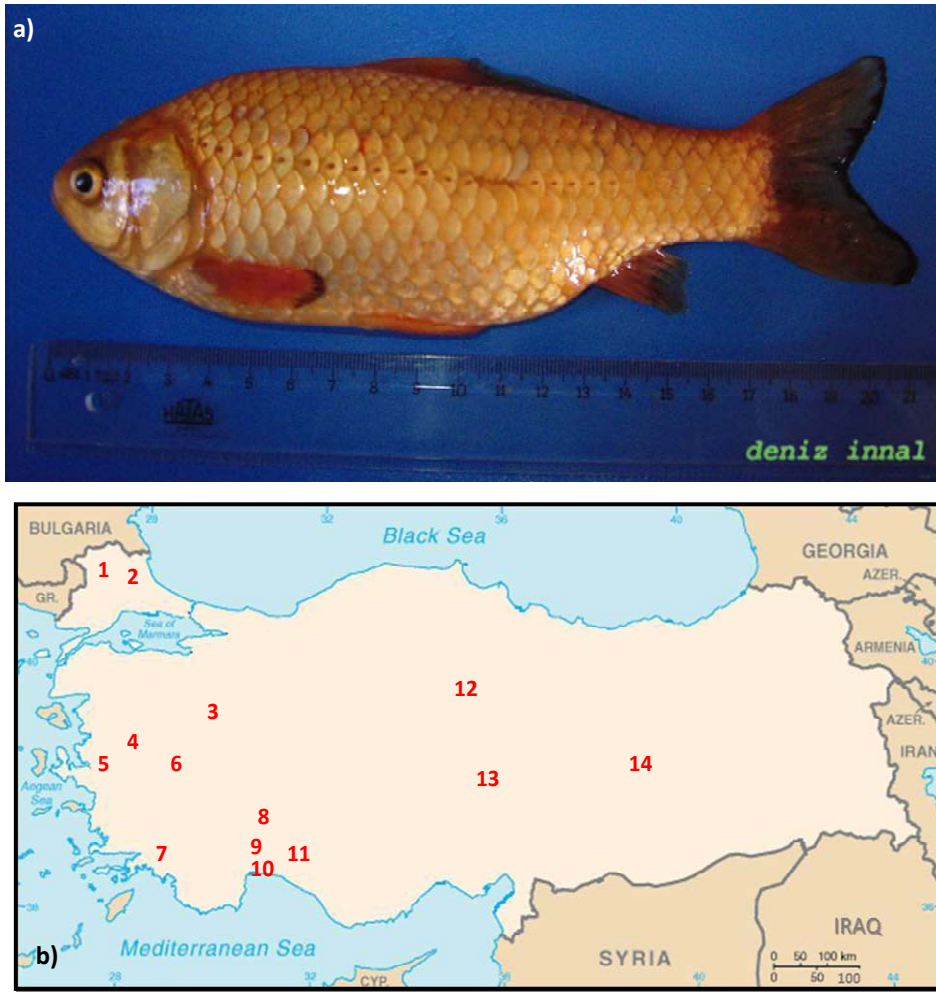
**Table 1 (cont).** Distribution of *C. auratus*, *C. carassius* and *C. gibelio* in the inland waters of Turkey

References included in Table 1. [Geldiay & Balık 1974; Balık et al. 1991; Erdem et al. 1994; Yalcın 1997; Bulut et al. 1997; Koyun et al. 1997; Alaş et al. 1998; Becer et al. 1998; Kır 1998; Cetinkaya et al. 1999; Taran et al. 2000; Balık & Cubuk 2001; Becer & İkiz 2001; Koyun 2001; Duman & Sen 2002; Aydın Olmez & Kuru 2003; Balık et al. 2003; Ekmekci & Ozeren 2003; Kılıç 2003; Ozulug 2003; Sasi & Balık 2003a; Sasi & Balık 2003b; Aygun et al. 2004; Balık S. et al. 2004; Emence 2004; İzci 2004; Kalous et al. 2004; Kucuk & İkiz 2004; Ozuluğ et al 2004; Topkara & Balık 2004; Yılmaz 2004; Anonymous 2005; İlhan et al 2005; Kır 2005; Ozulug et al. 2005a; Tekin- Ozan & Kır 2005; Soyulu & Emre 2005; Yılmaz & Polat 2005; Yılmaz et al. 2005; Yıldız et al. 2005; Artar & Akgun 2006; Aydogdu 2006; İlhan 2006; Innal & Erk'akan 2006; Kusat et al. 2006; Onaran et al. 2006; Ozturk & Bulut 2006; Tarkan et al. 2006; Yegen et al. 2006; Mendil & Uluozlu 2007; Ozcan 2007; Ozulug et al. 2007; Ugurlu & Polat 2007; Fidan et al. 2008; Innal 2008; Sarı et al. 2008; Ozdemir et al. 2010; Sungur 2010; Bulut 2010; Emiroglu et al. 2010; Erdogan et al. 2010; Heckmann et al. 2010; Ozbek & Ozturk 2010; Onsoy et al. 2011].

Parameters	Species					
	<i>C. auratus</i>		<i>C. carassius</i>		<i>C. gibelio</i>	
	Status	References	Status	References	Status	References
Adapt to natural waters	x	3,17	x	1,19,21	x	2,4,10
Adapt to altered waters	x	5	x	18,20	x	8,9,10,22
Adapt to various physical and chemical factors	x	12	x	1,18	x	8,9,10,12
Self maintaining populations	x	3,5	x	1,18,19,20,21	x	2,4,8,9,10,22
Fast- growing	unr		unr		x	10
High reproductive potential	x	3,12	x	1	x	9,10,12,22
Gonochoristic reproduction	x	3	x	1,18,19	x	4
Triploidy	unr		unr		x	10
Dominancy	x	3,11,17	x	1,11,19,20	x	2,8,9,10,11
Invasive/ dispersal tendency	unr		x	1	x	8,9
Harmful impact on the aquatic flora-fauna	x	14	x	1,7	x	2,4,9,10
Harmful competition with native species	x	11,16,17	x	7,11,21	x	9,10,11,15,22
Hybridization with native species	unr		x	1	x	13
Filling a vacant or a little used ecological niche	unr		x	1,19	unr	
Host or a intermediate host of parasites	x	23	x	23,24,25,26,27,28,29	x	6
Interspecific competition	unr		x	1	x	2,4

**Table 2.** Ecological status and some risk parameters of species

References included in Table 2. (Unr: unreported), [1] Cetinkaya et al. 1999, [2] Balık et al. 2003, [3] Kusat et al. 2006, [4] Balık et al. 2004, [5] Balık et al. 2000, [6] Arslan & Emiroglu 2011, [7] Yılmaz 2004, [8] Ozulug et al. 2004, [9] Ozulug et al. 2005b, [10] Tarkan et al. 2006, [11] Balık & Ustaoglu 2006, [12] Cetinkaya 2006, [13] Yegen et al. 2006, [14] Kesici et al. 2006, [15] Sası & Balık 2003a, [16] Kucuk & Ikiz 2004, [17] Izci 2004, [18] Bulut et al. 1997, [19] Taran et al. 2000, [20] Becer et al. 1998, [21] Balık et al. 1991, [22] Sası & Balık 2003b, [23] Koyun 2001, [24] Emence 2004, [25] Koyun et al. 1997, [26] Soylu & Emre 2005, [27] Tekin Ozan & Kir 2005, [28] Kir 1998, [29] Aydogdu 2006.



**Figure 1.** Aspect (a) and distribution map (b) of *Carassius auratus* [1) Tunca River; 2) Bulanık Creek; 3) Enne Dam Lake; 4) Marmara Lake; 5) Karagöl Lake; 6) Alahabalı Pond- Gögem Pond- Güneyköy Pond- Kızılhisar Pond- Kuşdemir Pond- Takmak Pond- Üçpınar Pond; 7) Ula Lake; 8) Eğirdir Lake; 9) Karacaören Dam Lake; 10) Aksu River- Köprüçay River; 11) Eğrigöl Lake- Karın Lake; Manavgat Dam Lake; Oymapınar Dam Lake; 12) Gelingüllü Lake; 13) Kızılırmak River-Kayseri; 14) Keban Dam Lake]

al. 2004) and Eğirdir Lake (Balık et al. 2006).

Rapid increases in population abundance of this species have been reported in several systems in Turkey, like elsewhere in the world [including southern Russia (Abramenko et al. 1997), Greece (Paschos et al. 2001) and the Danube River basin (Holcik 1980)].

Possible impacts of *Carassius* species on aquatic environment include: direct predation on native fauna and flora, competition with indigenous fish for food, spawning localities, and habitat, the introduction of new parasites or diseases. The principal threat to native fish species of Turkey is probably competition for food and spawning sites.

Competition with native

species for food and spawning sites have been reported for *Carassius* species. Uncontrolled, vigorous reproduction of this species lead to direct or indirect competition, and eventual elimination of, native species.

Species compete with *Cyprinus carpio* for food and space in several systems (Mumcular Dam Lake, Nazik Lake). Economic losses of *C. carpio* stocking practices have been continuing for many years as there is not any monitoring or evaluation program of the stocking practices.

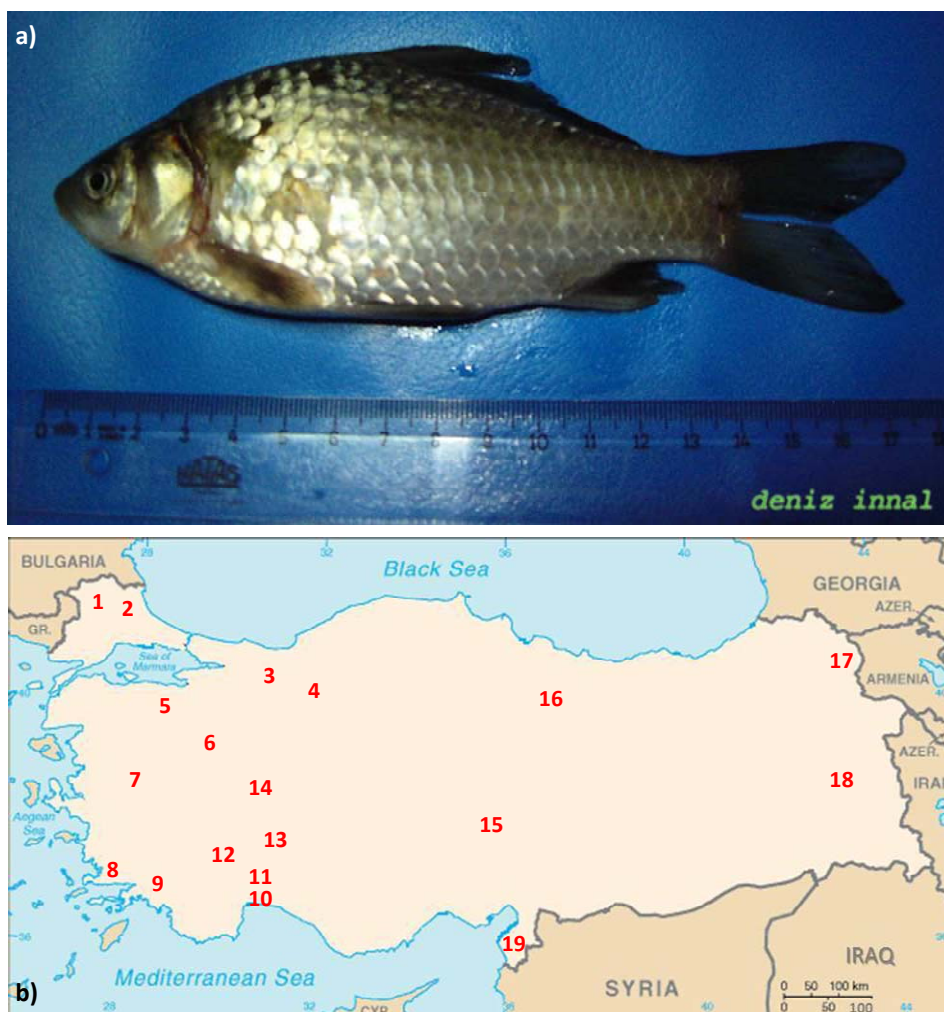
Food competition was reported between the *C. carassius* and *Alburnus tarichi* (Guldenstädt, 1814) (endemic species for Lake Van Basin) in Lake Nazik (Cetinkaya et al. 1999).

Food competition was reported between the *C. gibelio* and other species such as pike perch, *Sander lucioperca* (Linnaeus 1758), Common carp, *C. carpio*, Baltic Vimba, *Vimba vimba* (Linnaeus 1758) and Crayfish, *Astacus leptodactylus* Eschscholtz, 1823 (Balık et al. 2003). Otherwise, *C. carpio* and *V. vimba* in the lake may be negatively affected in the future (Balık et al. 2004). According to Sasi & Balık (2003b) *C. gibelio* compete with *Squalius cephalus* (Linnaeus 1758) for food.

*C. gibelio* is known as one of the most hazardous fish species for native fish communities (Crivelli 1995, Kalous et al. 2004). It appears to occupy an unexpected ecological niche or even lead to unexpected changes in the behavior of native species. Species would have significant negative impacts on the food web and the trophic structure of aquatic systems by inducing changes in the lower trophic levels. It may change the flow of nutrients in the entire ecosystem (Paulovits et al. 1998). Species would predate heavily on phytoplankton and zooplankton, and strongly compete with the young of most cyprinid fish species. The species appear to be a serious competitor of native fish species in Turkey.

According to the highest degree of invasion (Table 1, Figure 6) *C. gibelio* is suggested to have effective dispersal tendency. The presence of gynogenesis provides the dispersal tendency and an increase on population density (Vetemaa 2005; Tarkan et al. 2006).

According to Vetemaa, 2005 Invading populations are often triploid and composed of almost exclusively females, which exhibit apomictic (gynogenetic) reproduction - using the sperm of other species to activate (but not fertilize) their own eggs. Triploid individuals have been reported in Kayalıköy Dam Lake in Turkey



**Figure 2.** Aspect (a) and distribution map (b) of *Carassius carassius* [1) Gala Lake-Pamuklu Lake; 2) Hamam Lake; 3) Küçük Akgöl Lake- Sapanca Lake- Taşkırsığı Lake; 4) Yeniçağa Lake; 5) Uluabat Lake- Gölbaşı Dam Lake; 6) Kayaboğazı Dam Lake-Yedigöller Pond; 7) Marmara Lake- Avşar Dam Lake; 8) Mumcular Dam Lake; 9) Eşen Stream- Geyik Dam Lake; 10) Aksu River-Köprüçay River- Kepez Dam Lake; 11) Karacaören Dam Lake; 12) Karataş Lake; 13) Kovada Lake- Eğirdir Lake; 14) Selevir Dam Lake- Eber Lake; 15) Zamantı Stream; 16) Almus Dam Lake- Ataköy Dam Lake; Yarseli Dam Lake; 17) Kars Creek; 18) Nazik Lake; 19) Asi River]

(Kalous et al. 2004). Triploids present some enhanced performance, such as faster growth rate, wide adaptability; sterility and disease resistance (Sun 2006). Polyploidy was observed in *C. auratus* in Kızılırmak River (Aydın Olmez & Kuru 2003).

*C. auratus* is evaluated having high reproductive potential and forming degenerate populations

(Cetinkaya 2006). Hybridization has been reported between the introduced Cyprinid, *C. carassius* and native Cyprinid, *C. carpio* in Nazik Lake (Cetinkaya et al. 1999).

The parasite fauna of alien fish species from natural and altered aquatic habitats in Turkey have rarely been investigated and consequently little is known about

it. Nine parasite species were reported from *Carassius* genus (Geldiay & Balık 1974; Koyun et al. 1997; Kir 1998; Koyun 2001; Emence 2004; Soylu & Emre 2005; Tekin-Ozan & Kir 2005; Aydogdu 2006; Arslan & Emiroglu 2011). A Arthropoda *Argulus foliaceus* and a Monogenea *Dactylogyrus anchoratus* are the common parasites of species. *Gyrodactylus carassii* was probably introduced in Turkey with species of *Carassius* genus.

The effects of fish species introduction on a waterbody are complex and apparently depend on the stocking density, macrophyte abundance and community structure of the ecosystem. The introduction of species into an aquatic system has been shown to directly, or indirectly, impact aquatic macrophytes, water quality and aquatic fauna including plankton, benthic macroinvertebrates, fishes and wildlife.

Population density of the *Carassius* species have increased rapidly in the inland waters of Turkey, and now it is the dominant fish species of some aquatic systems. Control strategies are limited. The ecology of this species, its role in its ecosystem, its relationships with other organisms and the role of parasites and diseases were not be thoroughly investigated. The results and effects

of previous introduction of this species in other countries were not examined. Based on the results of its introduction throughout the

country, the introduction does not show to meet clear ecological, economical or recreational need.



**Figure 3.** Aspect (a) and distribution (b) of *Carassius gibelio* [ 1) Kınıklı Creek; 2) Gala Lake- İbriktepe Pond- Çöpköy Pond- Bülbüldere Pond- Çamlıca Creek- Tunca River- Meriç River; 3) Arnavut Creek- Bulanık Creek- Saka Lake- Sarıcaali Pond- Kayalı Dam Lake; 4) Büyükçekmece Dam Lake- Ömerli Dam Lake- Durusu Lake; 5) Sapanca Lake; 6) Kunduzlar Dam Lake- Porsuk Dam Lake; 7) Ağaçköy Creek- Felek Creek; 8) Ulubat Lake- İznik Lake; 9) Kavaklı Creek; 10) Manyas Lake- İkizcetepeler Pond; 11) Marmara Lake- Avşar Dam Lake; 12) Gölcük (İzmir) Lake; 13) Akçay Stream- Kemer Dam Lake- Topçam Dam Lake; 14) Ula Lake- Geyik Dam Lake; 15) Adıgüzel Dam Lake- Buldan Dam Lake- Işıklı Lake- Yayla Lake; 16) Gögem Pond- Güneyköy Pond- Kızılıhisar Pond- Kuşdemir Pond- Takmak Ponds- Üçpınar Pond- Baltalı Pond- Dümenler Pond- Eşme Creek- Mesudiye Pond- Alahabalı Pond- Yenice Pond- Yeşilkavak Pond- 17) Seyitler Dam Lake; 18) Eğirdir Lake- Gölcük (Isparta) Lake; 19) Beyşehir Lake; 20) Eğrigöl Lake; 21) Aksu River- Köprüçay River; 22) Altınapa Dam Lake; 23) Seyhan Dam Lake; 24) Kızılırmak River; 25) Gelingüllü Lake; 26) Bektaşağa Pond- Nisi Pond; 27) Abdal Creek- Balık Lake- Çakmak Dam Lake- Çernek Lake- Çobanlar Creek- Divanbaşı Pond- Gıcı Lake- Karaboğaz Lake- Liman Lake- Mert Creek- Miliç Creek- Simenit Lake- Suat Uğurlu Dam Lake- Tatlı Lake- Terme Creek- Uzungöl Lake- Yurtluk Creek; 28) Boztepe Dam Lake]



## References

- Abramenko MI, Kravchenko OV, Velikoivanenko AE (1997)** Population genetic structure of the goldfish *Carassius auratus gibelio* diploid–triploid complex from the Don River Basin. *Journal of Ichthyology* 37: 56–65.
- Alas A, Yılmaz F, Solak K (1998)** Adaptation and competition of tench (*Tinca tinca* L., 1758) implanted to the Kayabogaazi Dam Lake (Tavsanlı-Kutahya). The Proceedings of the First International Symposium on Fisheries and Ecology, pp: 466–468.
- Anonymous (2005)** Bulletin of statistics DSI (State Water Works). Republic of Turkey, Ankara, 571 pp.
- Arslan N, Emiroglu O (2011)** First record of parasitic Annelida-Hirudinea (*Piscicola geometra* Linnaeus, 1761) on *Carassius gibelio* (Bloch, 1782) in Lake Uluabat (Turkey). *The Journal of the Faculty of Veterinary Medicine, University of Kafkas* 17 (1): 131-133.
- Artar E, Akgun H (2006)** Adıyaman ilinde yürütülen balıklandırma çalışmalarının balıkçılığa etkisi, 1. Ulusal balıklandırma ve rezervuar yönetimi sempozyumu bildirileri, TKB Akdeniz Su Urunleri Araştırma, Üretim ve Eğitim Enstitüsü Yayınları: 1, pp: 377-382.
- Aydin Olmez D, Kuru M (2003)** Karyotype of the *Carassius auratus* (L., 1758) live in Kızılırmak (Kayseri- Turkey). *Gazi University Journal of Gazi Educational Faculty* 21(3): 33-37.
- Aydogdu A (2006)** Variations in the infections of two Monogenean species parasitizing the gills of the crucian carp (*Carassius carassius*), in relation to water temperature over a period of one year in Gölbaşı Dam Lake, Bursa, Turkey. *Bulletin of European Association of Fish Pathologists* 26(3): 112-118.
- Aygun O, Yarsan E, Akaya R (2004)** Lead and copper levels in muscle meat of crucian carp (*Carassius carassius* L. 1758) from Yarseli Dam Lake, Turkey. *Bulletin of Environmental Contamination and Toxicology* 72: 135-140.
- Balık I, Cubuk H, Kucuk F (2000)** Age, weight and length distributions and condition factors of *Carassius carassius* L., 1758 and *Vimba vimba tenella* Nordmann, 1840 populations in Karacaören I Dam Lake (In Turkish with English summary). *Suleyman Demirel University Journal of Sciences* 4(1): 17-25.
- Balık I, Cubuk H (2001)** Selectivity of gillnets on fishing roach (*Rutilus rutilus* L., 1758) and shad (*Alosa maeotica* Grimm, 1901) in lake Uluabat (Apolyont) (In Turkish with English summary). *Suleyman Demirel University Journal of Sciences* 5(3): 21–32.
- Balık I, Karasahin B, Ozkok R, Cubuk H, Uysal R (2003)** Diet of silver crucian carp *Carassius gibelio* in Lake Eğirdir. *Turkish Journal of Fisheries Aquatic Sciences* 3: 87-91.
- Balık I, Ozkok R, Cubuk H, Uysal R (2004)** Investigation of some biological characteristics of the silver crucian carp, *Carassius gibelio* (Bloch 1782) population in Lake Eğirdir. *Turkish Journal of Zoology* 28: 19-28.
- Balık I, Cubuk H, Ozkok R, Uysal R (2006)** Fish fauna and fisheries in Lake Eğirdir: Changes from 1950s, when pikeperch (*Sander lucioperca* (Linnaeus, 1758) was introduced to today (In Turkish with English Summary). *Symposium on Management of Reservoirs and Fish Stocking, MARA, Mediterranean Fisheries, Production and Education Institute: 105-118.*
- Balık S, Ustaoglu MR, Sari HM (1991)** Investigation on the bioecological characteristics of *Carassius carassius* L., 1758 population in Lake Marmara (Salihli) (In Turkish with English Summary). *Eğitiminin 10. Yılında Su Urunleri Sempozyumu, İzmir*, pp: 43-56.
- Balık S, Sari HM, Ustaoglu MR, Ilhan A (2004)** Age and growth characteristics of chub (*Leuciscus cephalus* L., 1758) population in Isıklı Lake, Civril, Denizli, Turkey (In Turkish with English Summary). *Ege University Journal of Fisheries and Aquatic Sciences* 21, 3-4: 257– 262.
- Balık S, Ustaoglu MR (2006)** Fish introducing studies in Lakes, Ponds and Reservoirs of Turkey and their results (In Turkish with English Summary). I. *Symposium on Management of Reservoirs and Fish Stocking, MARA, Mediterranean Fisheries, Production and Education Institute*, pp: 1-10.
- Becer ZA, Kir I, Cubuk H (1998)** Some reproductive characteristics of the *Carassius carassius* L., 1758 (Isparta- Burdur) in the Karacaören I Dam Lake (In Turkish with English Summary). *XIV. Ulusal Biyoloji Kongresi, Samsun*, pp: 126-138.
- Becer ZA, İkiz R (2001)** Investigation of some biological characters of the *Vimba vimba tenella* (Nordmann, 1840) population in Karacaören I Dam Lake (In Turkish with English Summary). *Turkish Journal of Veterinary and Animal Science* 25:111-117.
- Bulut S, Yılmaz F, Alas A, Koyun M, Solak K (1997)** Growth characteristics of *Carassius carassius* L., 1758 in Yedigöller (Upper Porsuk Basin-Kutahya) (In Turkish with English Summary). *IX. Ulusal Su Urunleri Sempozyumu, Isparta*, pp: 117-132.

- Bulut S (2010)** The variation of the fatty acid composition in muscle tissue of *Carassius gibelio* living in Seyitler Dam Lake (Afyonkarahisar) (In Turkish with English Summary). *Electronic Journal of Food Technologies* 5 (2): 69-75.
- Cetinkaya O, Elp M, Sen F (1999)** Studies on crucian carp (*Carassius carassius* L.) introduced into Lake Nazik (Ahlat- Bitlis, Turkey) (In Turkish with English Summary). X. Ulusal Su Urunleri Sempozyumu, Adana, pp: 814-825.
- Cetinkaya O (2006)** Exotic and native fish species that introduced or stocked into Turkish waters, their impacts on Aquaculture, fisheries, wild populations and aquatic ecosystems: A preliminary study on constructing A database (In Turkish with English Summary). Symposium on Management of Reservoirs and Fish Stocking, MARA, Mediterranean Fisheries, Production and Education Institute, pp: 205-235.
- Copp GH, Garthwaite R, Gozlan RE (2005)** Risk identification and assessment of non-native freshwater fishes: concepts and perspectives on protocols for the UK. *Sci. Ser. Tech Rep., Cefas Lowestoft*, 129, 32 pp.
- Crivelli AJ (1995)** Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region? *Biological Conservation* 72: 311-319.
- Duman E, Sen D (2002)** The comparative age determination of *Carassius auratus* (L., 1758) living in Keban Dam Lake (In Turkish with English Summary). *Gazi University Journal of Gazi Educational Faculty* 22, 3: 11-18.
- Ekmekci FG, Ozeren SC (2003)** Reproductive biology of *Capoeta tinca* in Gelingullu Reservoir, Turkey. *Folia Zoologica* 52(3): 323-328.
- Emence H (2004)** Helminthological investigation of *Carassius carassius* living in Ulubat (Apoloyont) Lake, Msc Thesis, Uludag University, 49 pp.
- Emiroglu O, Uyanoglu M, Canbek M, Baskurt S (2010)** Erythrocyte sizes of *Carassius gibelio* species in Porsuk Dam Lake (Eskisehir/Turkey). *Journal of Animal and Veterinary Advances* 9 (24): 3077-3082.
- Erdem U, Kirgiz T, Guher H, Tureli C (1994)** Some biological properties of *Scardinius erythrophthalmus* L., 1758 and *Carassius carassius* L., 1758 (Pisces) in Hamam Lake (Igneada-Kirklareli) (In Turkish with English Summary). XII Ulusal Biyoloji Kongresi, Edirne, pp: 122-128.
- Erdogan Z, Ustun F, Gungor S, Torcu Koc H, Oktener A (2010)** Growth characteristics of crucian carp, *Carassius carassius* in Ikizcetepeler Dam Lake, Balikesir, Turkey, IV. International Symposium of Ecologists of Republic of Montenegro, ISEM4.
- Fidan AF, Cigerci IH, Konuk M, Kucukkurt I, Aslan R, Dundar Y (2008)** Determination of some heavy metal levels and oxidative status in *Carassius carassius* L., 1758 from Eber Lake. *Environmental Monitoring and Assessment* 147: 35-41.
- Geldiyar R, Balik S (1974)** Ecto and endoparasites found the freshwater fish of Turkey (In Turkish). Ege University, The Science Faculty Monographies, 14, Ege University Press, Bornova, 34 pp.
- Heckmann RA, Oguz MC, Amin OA, Dusen S, Tepe Y, Aslan B (2010)** Host and geographical distribution of *Pomphorhynchus spindlettrancatus* (Acanthocephala: Pomphorhynchidae) in Turkey, with enhanced description from new fish and amphibian hosts using SEM, and histopathological notes. *Sci Parasitol.* 11 (3): 129-139.
- Holcik J (1980)** Possible reason for the expansion of *Carassius auratus* (Linnaeus, 1758) (Teleostei, Cyprinidae) in the Danube River Basin. *International Revue Gesamten Hydrobiologie* 65: 673-679.
- Ilhan A, Balik S, Sarı HM, Ustaoglu MR (2005)** *Carassius* (Cyprinidae, Pisces) species in inland waters of Western and Middle Anatolia, Southern Marmara, Thrace and Western Black Sea Regions and their distributions (In Turkish with English Summary). *Ege University Journal of Fisheries and Aquatic Sciences* 22 (3-4): 343-346.
- Ilhan A (2006)** Batı Karadeniz bölgesi tatlısu balıklarının taksonomik ve ekolojik özelliklerinin araştırılması, Doktora Tezi, Ege Üniversitesi Fen Bilimleri Enstitüsü, 186 pp.
- Innal D, Erk'akan F (2006)** Effects of exotic and translocated fish species in the inland waters of Turkey. *Reviews in Fish Biology and Fisheries* 16:39-50.
- Innal D (2008)** Comparison of fish species diversity living in Estuary zone of Aksu and Koprucay rivers, Phd Thesis, Hacettepe University, 192 pp.
- Izci L (2004)** Some population parameters of *Carassius auratus* (L., 1758) in Lake Egirdir (In Turkish with English Summary). *Turkish Journal of Veterinary and Animal Science* 28: 23-27.
- Kalous L, Memis D, Bohlen J (2004)** Finding of triploid *Carassius gibelio* (Bloch, 1780) (Cypriniformes, Cyprinidae) in Turkey. *Cybiu* 28(1): 77-79.
- Kesici E, Becer Ozvarol ZA, Ikiz R, Kesici C (2006)** The effect of macroflora in lakes of introduced into Natural Lakes. Symposium on Management of Reservoirs and Fish Stocking, MARA,

Mediterranean Fisheries, Production and Education Institute, pp: 415-421.

- Kılıç S (2003)** Population and fishing of carp (*Cyprinus carpio* L., 1758) in Yenicağa Lake (In Turkish with English Summary). Msc Thesis, Karadeniz Teknik University, 80 pp.
- Kır I (1998)** Investigation of parasites of carp (*Cyprinus carpio* L., 1758) and barbus (*Barbus capito pectoralis* L., 1758) and crucian carp (*Carassius carassius* L., 1758) living in Karacaoren Dam Lake (In Turkish with English Summary). PhD Thesis, Suleyman Demirel University, 78 pp.
- Kır I (2005)** Fish, amphibian and reptile fauna of Karatas Lake (Burdur) and its surrounding. *Ekoloji* 14(56): 23-25.
- Koyun M (2001)** The helminthofauna of some fishes in Enne Dam Lake (In Turkish with English Summary). Phd Thesis, Uludag University, 119 pp.
- Koyun M, Bulut, S., Yılmaz, F., Alas, A. and Solak, K. (1997)** An investigation on *Argulus foliaceus* L. seen some fish species of Cyprinidae in Kutahya and its vicinity. *Ulusal Su Urunleri Sempozyumu, Bildiriler Kitabı*, 1: 392-398.
- Kusat M, Koca HU, İzci L (2006)** A study on the determination of some parameters of the silver prussian carp *Carassius auratus* (Bloch, 1782) caught in the area of Eğirdir Lake in Terms of Fishery Biology (In Turkish with English Summary). *Suleyman Demirel University Journal of Science* 10 (1): 61-65.
- Kucuk F, İkiz R (2004)** Fish fauna of streams discharging to Antalya Bay (In Turkish with English Summary). *Ege University Journal of Fisheries and Aquatic Sciences* 21(3-4): 287-294.
- Mendil D, Uluozlu UD (2007)** Determination of trace metal levels in sediment and five fish species from Lakes in Tokat, Turkey. *Food Chemistry* 101:739–745.
- Onaran MA, Ozdemir N, Yılmaz F (2006)** The fish fauna of Esen Stream (Fethiye-Mugla). *International Journal of Science and Technology* 1 (1): 35-41.
- Onsoy B, Tarkan AS, Filiz H, Bilge G (2011)** Determination of the best length measurement of fish, North-western *Journal of Zoology* 7 (1): on-first.
- Ozbek M, Ozturk MO (2010)** Investigations on *Ligula intestinalis* L., 1758 plerocercoid infection of some fishes from Dam Lake Kunduzlar (Kirka-Eskisehir) (In Turkish with English Summary). *Acta Parasitologica Turcica* 34 (2): 112 – 117.
- Ozcan G (2007)** Distribution of non-indigenous fish species, prussian carp *Carassius gibelio* (Bloch, 1782) in the Turkish Freshwater Systems. *Pakistan Journal of Biological Sciences* 10 (23): 4241-4245.
- Ozdemir N, Yılmaz F, Tuna AL, Demirak A (2010)** Heavy metal concentrations in fish (*Cyprinus carpio* and *Carassius carassius*), sediment, and water found in the Geyik Dam Lake, Turkey. *Fresenius Environmental Bulletin* 19 (5): 798-804.
- Ozturk MO, Bulut S (2006)** An investigation on the metazoan parasite fauna of *Cyprinus carpio* L. (common carp) from Lake Selevir Dam (Afyonkarahisar) (In Turkish with English Summary). *Science and Engineering Journal of Fırat University* 18(2): 143-149.
- Ozulug M (2003)** Durusu (Terkos) Gölü Havzası balıkları ve bunlardan Turna balığı (*Esox lucius* Linnaeus, 1758)'nin biyolojisi üzerinde araştırmalar, PhD Thesis, Istanbul University, 81 p.
- Ozulug M, Meric N, Freyhof J (2004)** The distribution of *Carassius gibelio* (Bloch, 1782) (Teleostei: Cyprinidae) in Thrace (Turkey). *Zoology in the Middle East* 31: 63-66.
- Ozulug M, Altun O, Meric N (2005a)** On the fish fauna of Lake Iznik (Turkey). *Turkish Journal of Zoology* 29: 371-375.
- Ozulug M, Acıpinar H, Gaygusuz O, Gursoy C, Tarkan AS (2005b)** Effects of human factor on the fish fauna in a drinking-water resource (Omerli Dam Lake-Istanbul, Turkey). *Research Journal of Agriculture and Biological Sciences* 1(1): 50-55.
- Ozulug M, Tarkan AS, Gaygusuz O, Gursoy C (2007)** Two new records for the fish fauna of Lake Sapanca Basin, *Journal of FisheriesSciences.com* 1 (3): 152-159.
- Paschos I, Nathanailides K, Samara E, Gouva E, Tsoumani M (2001)** Presence of gibel carp (*Carassius auratus gibelio*) in Lake Pamvotis in Greece: Spawning behaviour characteristics and prospects for controlling the population. In: *Proceedings of Panellenic Congress of Ichthyologists*, Chania, 18–20 Oct 2001. *Praktika*, Athens, pp: 245–248.
- Paulovits G, Tatrai I, Matyas K, Korponai J, Kovats, N (1998)** Role of Prussian carp (*Carassius auratus gibelio* Bloch) in the nutrient cycle of the Kis-Balaton Reservoir. *International Review of Hydrobiology* 83 (Suppl.): 467–470.
- Sarı HM, Balık S, Ustaoglu R, İlhan A (2008)** Population structure, growth and mortality of *Carassius gibelio* (Bloch, 1782) Buldan Dam Lake. *Turkish Journal of Fisheries Aquatic Sciences* 8: 25-29.
- Sası H, Balık S (2003a)** The distribution of Three Exotic Fishes in Anatolia. *Turkish Journal of Zoology* 27: 319-322.

- Sası H, Balık S (2003b)** Age, growth and sex ratio of chub (*Leuciscus cephalus* L., 1758) in Topcam Dam Lake (Aydın) (In Turkish with English Summary). Ege University Journal of Fisheries and Aquatic Sciences 20 (3-4): 503-515.
- Soylu E, Emre Y (2005)** Metazoan parasites of *Clarias lazera* Valenciennes, 1840 and *Carassius carassius* (Linnaeus, 1758) from Kepez I Hydro Electric Power Plant Loading Pond, Antalya, Turkey. Turkish Journal of Fisheries Aquatic Sciences 5: 113-117.
- Sun YD, Zhang C, Liu SJ, Tao M, Zeng C, Liu Y (2006)** Induction of Gynogenesis in Japanese Crucian Carp (*Carassius cuvieri*) Acta Genetica Sinica 33 (5): 405-412.
- Sungur M (2010)** Fish species found in the Lakes, Ponds and Dams of Sinop Province, Turkey (In Turkish with English Summary), Msc Thesis, Sinop University, 96p.
- Taran HB, Kucuk F, Becer ZA (2000)** The investigation of population structure and some reproduction characters of crucian carp (*Carassius carassius* L., 1758) in Lake Egirdir (In Turkish with English Summary). Ulusal Ogrenci Su Urunleri Sempozyumu, pp: 11.
- Tarkan AS, Gaygusuz O, Gursoy C, Acipinar H, Bilge G (2006)** A new predator species *Carassius gibelio* (Bloch, 1782) in Marmara Region: Successful or not (In Turkish with English Summary). Symposium on Management of Reservoirs and Fish Stocking, MARA, Mediterranean Fisheries, Production and Education Institute, pp: 195-204.
- Tekin-Ozan S, Kir I (2005)** An Investigation of Parasites of Goldfish (*Carassius carassius* L., 1758) in Kovada Lake (In Turkish with English Summary). Acta Parasitologica Turcica 29 (3): 202-203.
- Topkara ET, Balık S (2004)** Biological investigation of Barbel fish (*Barbus capito pectoralis* Heckel, 1843) population in Avsar Dam Lake (Sarigöl, Manisa, Turkiye) (In Turkish with English Summary). Ege University Journal of Fisheries and Aquatic Sciences 21 (3-4): 253- 256.
- Ugurlu S, Polat N (2007)** Exotic fish species inhabiting in freshwater sources within the province of Samsun (In Turkish with English Summary). Journal of FisheriesSciences.com 1(3): 139-151.
- Vetemaa M, Eschbaum R, Albert A, Saat T (2005)** Distribution, sex ratio and growth of *Carassius gibelio* (Bloch) in coastal and inland waters of Estonia (North-Eastern Baltic Sea) Journal of Applied Ichthyology 21: 287–291.
- Yalcın S (1997)** Fish fauna of Asi River (Orontes) and its Branch (In Turkish with English Summary). X. Ulusal Su Urunleri Sempozyumu 22-24 Eylül, Adana, pp: 73-80.
- Yegen V, Balık S, Bostan H, Uysal R, Bilcen E (2006)** Recent status of fish fauna in some Lakes and Dams in Lakes Region. Symposium on Management of Reservoirs and Fish Stocking, MARA, Mediterranean Fisheries, Production and Education Institute, pp: 129-139.
- Yıldız S, Tasdemir A, Ozbek M, Balık S, Ustaoglu MR (2005)** Macrobenthic invertebrate fauna of Lake Eğrigöl (Gündoğmus – Antalya). Turkish Journal of Zoology 29 (3): 275-282.
- Yılmaz F (2004)** Physico-chemical features of Mumcular Dam Lake (Muğla-Bodrum) (In Turkish with English Summary). Ekoloji 13 (50): 10-17.
- Yılmaz M, Polat N (2005)** Digestive system contents of the pike (*Esox lucius* L., 1758) inhabiting Simenit Lake (Terme-Samsun) (In Turkish with English Summary). Fırat University Journal of Science and Engineering 17 (3): 573-580.
- Yılmaz M, Yazıcıoğlu O, Polat N (2005)** Samsun-Bafra Balık Gölleri'nde yaşayan havuz balığı (*Carassius auratus gibelio* Bloch, 1783)'nın beslenme rejimi. XIII. Ulusal Su Urunleri Sempozyumu, pp: 6.

### Bio-sketch

**Deniz Innal** received his PhD degree in Hydrobiological Sciences from the University of Hacettepe, Turkey. He now holds assistant professor position in the Department of Biology at Mehmet Akif Ersoy University in Burdur, Turkey. He is currently interested in management programme and ecological impacts of introduced freshwater fish species.

### Authors

**INNAL, Deniz**  
innald@yahoo.com

Department of Biology, Mehmet Akif Ersoy University,  
15100, Burdur, Turkey.

Copyrights 2011 owned by The Authors