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Fish communities of the middle-upper Tagus River (central Spain): a story of river regulation and exotic introductions

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Abstract

Monitoring of fish communities in the middle-upper River Tagus was carried out from 1996. Owing to river regulation the original fluctuating and lotic condition of the river has been replaced by a mostly lentic environment. The native fish fauna consists of *Anguilla anguilla* and the Iberian endemics: *Barbus bocagei*, *Barbus comizo*, *Chondrostoma polylepis*, *Leuciscus pyrenaicus*, *Rutilus arcasii*, *Tropidophoxinellus alburnoides* and *Cobitis paludica*. Exotic fish have been introduced and are now established in the area: *Carassius auratus*, *Cyprinus carpio*, *Gobio gobio*, *Tinca tinca*, *Gambusia holbrooki*, *Esox lucius*, *Micropterus salmoides* and, more recently, *Lepomis gibbosus*, *Ameiurus melas* and *Stizostedion lucioperca*. Preliminary results show that eel is now absent due to downstream blockages, barbels are still common, but other native fish are rare. Exotic species, especially *C. carpio*, *Gambusia holbrooki*, *Micropterus salmoides* and *Lepomis gibbosus* are the most numerous species.
Key words: freshwater fish, introductions, river regulation, River Tagus, Spain

1. Introduction

The Tagus rises at an altitude of 1345 m in the Albarracín Mountains and flows 1007 km to the Atlantic Ocean close to Lisbon. The fish fauna of the Tagus River basin is included in the Central subsector of the Iberian biogeographical areas proposed by Doadrio (1988). Its fish composition was described by Almaça (1986), Doadrio (1988), Doadrio *et al.* (1991) and Elvira (1995a).

Stream regulation appears to have had a greater impact upon riverine fishes than any other human activity. In Spain, dams are considered to be one of the main negative factors affecting the native fishes (Blanco, González 1992, Elvira 1996). The headwaters and main course of the River Tagus are regulated by several dams and, consequently, the original fluctuating and lotic condition has been replaced by a regulated and mostly lentic environment. In addition, several exotic fish have been stocked in this disturbed environment and are a factor of threat for the native species (Elvira 1990, 1995a, 1995b, 1995c, 1996, 1997a, 1997b).

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Recent changes of fish faunas of Iberian large river systems were reviewed by Almaça (1986), for the Tagus and Guadiana; Lobón-Cerviá *et al.* (1989), for the Douro; Sostoa, Lobón-Cerviá (1989), for the Ebro and Granado-Lorencio (1991a), for the Guadalquivir.

Current fish communities of the River Tagus have been recently researched in reservoirs (Granado-Lorencio 1991b, Granado-Lorencio, García-Novo 1995) but not in streams. This report presents the preliminary results of a long-term research project to determine the qualitative and quantitative composition of the present fish assemblage in the middle-upper course of the River Tagus.

2. Material and methods

Monitoring of fish communities in the middle-upper section was carried out from June 1996. Monthly samples were taken at 20 localities between the Bolarque Dam and the confluence with the River Jarama (Fig. 1). This river section was about 150 km long and its altitude ranged from 480 to 642 m. The headwaters of Tagus are regulated by large dams. Thus, upstream the study area there were three large reservoirs (Entrepeñas, Buendía and Bolarque) with a total storage capacity of about 2472 hm^3. Furthermore, 13 dams and weirs formed a chain of impoundments along the studied river section.

Most samples were obtained by electrofishing, wading in shallow areas and from a boat in deeper parts. Complementary data on fish distribution were obtained using trammel nets and creel-surveys to anglers.

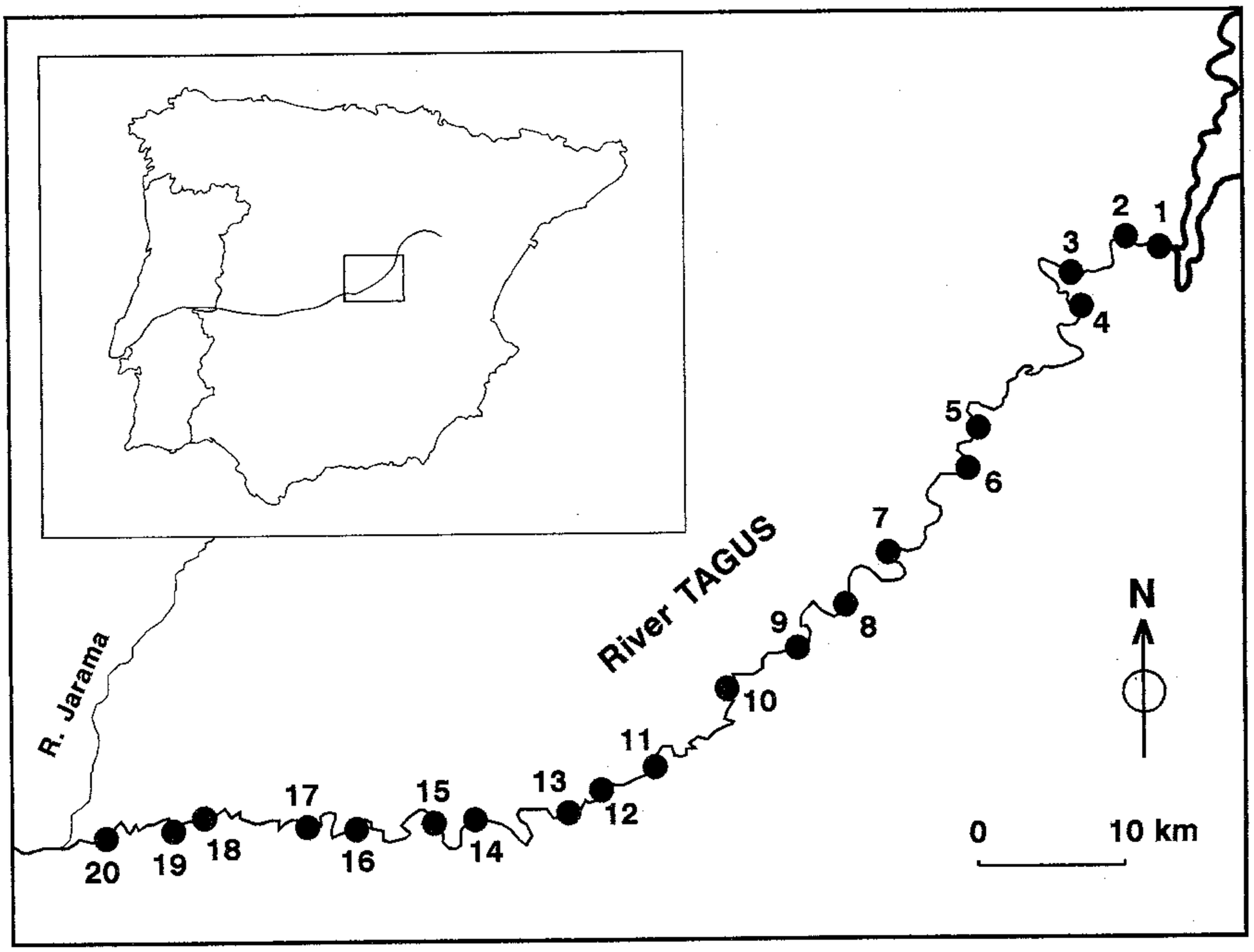

Fig. 1. Map of the study area. Sampling localities (upstream to downstream): 1 – Salto de Bolarque, 2 – Sayatón, 3 – Presa de Zorita, 4 – Zorita de los Canes, 5 – Central Eléctrica de Almoguera, 6 – Piscifactoría de Illana, 7 – Driebes, 8 – Salto de Valderribas, 9 – Chorros de Estremera, 10 – Fuentidueña de Tajo, 11 – Azud de Buenamesón, 12 – Villamanrique de Tajo, 13 – Azud de Villaverde, 14 – Central Eléctrica de Valdajos, 15 – Puente del Tajo, 16 – Azud de la Aldehuela, 17 – Casa del Soto, 18 – Casa de la Monta, 19 – La Pavera, 20 – El Rancho Grande

3. Results

The present fish fauna of the study area is listed in Tables I and II. Native species are the Iberian endemics *Barbus bocagei*, *Barbus comizo*, *Chondrostoma polylepis*, *Leuciscus pyrenaicus* and *Tropidophoxinellus alburnoides*. Two other native and endemic species, *Rutilus arcasii* and *Cobitis paludica* were caught in some nearby tributaries, but not in the main course of the Tagus.

Table I. Fish species found in the middle-upper Tagus River. N – native, En – Iberian endemism, Ex – exotic, Ex*–*A. anguilla* is a native species, but present occurrence is through introductions

	Origin		Abundance and distribution	
Family Anguillidae	N	Ex*	collected but not established	
Anguilla anguilla (L.)				
Family Cyprinidae				
Barbus bocagei Steindachner	N-En		common	wide
Barbus comizo Steindachner	N-En		common	wide
Carassius auratus (L.)		Ex	scarce	local
Chondrostoma polylepis Steindachner	N-En		scarce	local
Cyprinus carpio L.		Ex	common	wide
Gobio gobio (L.)		Ex	scarce	local
Leuciscus pyrenaicus Günther	N-En		scarce	local
Rutilus arcasii (Steindachner)	N-En		only found in tributaries	
Tinca tinca (L.)		Ex	scarce	local
Tropidophoxinellus alburnoides (Steindachner)	N-En		scarce	local
Family Cobitidae				
Cobitis paludica de Buen	N-En		only found in tributaries	
Family Ictaluridae				
Ameiurus melas (Rafinesque)		Ex	scarce	local
Family Esocidae				
Esox lucius L.		Ex	common	wide
Family Salmonidae				
Oncorhynchus mykiss (Walbaum)		Ex	collected but not established	
Family Poeciliidae				
Gambusia holbrooki (Girard)		Ex	common	wide
Family Percidae				
Stizostedion lucioperca (L.)		Ex	scarce	local
Family Centrarchidae				
Lepomis gibbosus (L.)		Ex	common	wide
Micropterus salmoides (Lacepède)		Ex	common	wide

Table II. Species distribution along the 20 selected localities. Upstream to downstream: 1 – Salto de Bolarque, 2 – Sayatón, 3 – Presa de Zorita, 4 – Zorita de los Canes, 5 – Central Eléctrica de Almoguera, 6 – Piscifactoría de Illana, 7 – Driebes, 8 – Salto de Valderribas, 9 – Chorros de Estremera, 10 – Fuentidueña de Tajo, 11 – Azud de Buenamesón, 12 – Villamanrique de Tajo, 13 – Azud de Villaverde, 14 – Central Eléctrica de Valdajos, 15 – Puente del Tajo, 16 – Azud de la Aldehuela, 17 – Casa del Soto, 18 – Casa de la Monta, 19 – La Pavera, 20 – El Rancho Grande

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Family Anguillidae																				
Anguilla anguilla					+	+														
Family Cyprinidae																				
Barbus bocagei	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Barbus comizo					+	+			+	+	+			+	+	+		+	+	+
Carassius auratus																		+	+	+
Chondrostoma polylepis					+	+	+								+			+	+	
Cyprinus carpio		+		+	+	+	+		+		+					+		+	+	+
Gobio gobio	+				+	+					+				+					+
Leuciscus pyrenaicus						+					+					+		+		
Tinca tinca			+	+	+	+	+				+									
Tropidophoxinellus alburnoides									+											
Family Ictaluridae																				
Ameiurus melas																				+
Family Esocidae																				
Esox lucius	+	+	+	+	+	+	+		+		+		+					+	+	+
Family Salmonidae																				
Oncorhynchus mykiss					+	+														
Family Poeciliidae																				
Gambusia holbrooki		+	+	+	+				+	+			+	+		+		+	+	+
Family Percidae																				
Stizostedion lucioperca			+	+	+															
Family Centrarchidae																				
Lepomis gibbosus	+		+	+	+	+	+	+	+		+			+	+	+	+	+	+	+
Micropterus salmoides	+		+	+	+	+	+	+	+		+			+		+	+	+	+	+

Native populations of *Anguilla anguilla* were extirpated as a result of downstream blockages (see Assis 1990, Nicola *et al.* 1996a for extirpation of migratory species). Nevertheless, scattered specimens of *A. anguilla* and *Oncorhynchus mykiss* were found in the River Tagus near a fish farm from where they had escaped. Consequently, these two species are not considered as established in the Tagus.

Likewise, exotic fish have been introduced and are now established in the area: *Carassius auratus*, *Cyprinus carpio*, *Gobio gobio*, *Tinca tinca*, *Gambusia holbrooki*, *Esox lucius*, *Micropterus salmoides*, *Lepomis gibbosus*, *Ameiurus melas* and *Stizostedion lucioperca*. All these aliens are mainly limnophilic fish, which have an advantage over the native rheophilic species because of the changes in the habitat.

C. auratus, *C. carpio* and *T. tinca* have been traditionally cultured and subjected to river stocking in Spain. More recently, during the 1940s and 1950s, colonization of the Tagus system by foreign species occurred as a consequence of administrative decisions. *G. holbrooki* was stocked in the area from 1942 to combat malaria. *E. lucius* was brought from France and stocked in the Tagus for the first time in Spain in 1949. Likewise, *M. salmoides* was first stocked for angling purposes in 1958. The remaining exotic species have become established in the area following casual introductions. Thus, the indiscriminate actions of anglers are responsible for the occurrence and spread of *G. gobio*, *L. gibbosus*, *A. melas* and *S. lucioperca*.

Preliminary quantitative results show that only the native barbels *B. bocagei* and *B. comizo* are still common, while the other native fish are rare. The exotic *L. gibbosus* was the most frequent and abundant species overall. Frequent species were also, in decreasing order, *M. salmoides*, *G. holbrooki* and *C. carpio*; whereas infrequent species comprised *C. polylepis*, *L. pyrenaicus* and *T. alburnoides*.

4. Discussion

The contemporary distribution of fishes within the Tagus reflects a long story of regulation and introductions. Besides the construction of main-stream reservoirs, the greatest impact of man upon the fish fauna of the Tagus has been stocking with exotic species.

Stream regulation has caused a great impact on freshwater communities of Spain (García de Jalón 1987), but ecological consequences are not well known yet (García de Jalón *et al.* 1992, Granado-Lorencio 1992). Dams have a definitive barrier-effect to upstream and downstream fish movements, apart from significative changes in the fluvial habitat. Two dams in the study area were constructed from 1530, but the rest were built between 1947 and 1957. This means that major impacts of river regulation occurred during the second half of this century, at the same time that exotic limnophilic fish became established. Many exotic species have been presented with new areas to colonize as a result of conversion of lotic river sections by reservoirs. In fact, introduced species have often been more successful in disturbed habitats (Crivelli 1995, Elvira 1997b).

Biological interactions have followed the introduction of foreign species, but their eventual replacement or extirpation of native species by competition or predation has never been assessed. However, it appears that native cyprinids and cobitids have been rather more stable in their distribution. Extirpation of native

fish species by exotic fish predators has not been tested yet in the Tagus, but it was described widely in the neighbouring Guadiana River basin (Almodóvar, Elvira 1994, Elvira, Barrachina 1996, Elvira *et al.* 1996, Nicola *et al.* 1996b).

National and International Environmental Laws ratified by Spain are against exotic species (Pintos 1997). Unfortunately, some private interests (anglers, fish farmers) are frequently in favour of fish introductions. The prospects are that more exotic fish will arrive to the Tagus in the near future, whilst some of those already established will become more common and widespread.

In conclusion, the study of the present fish community of the middle-upper Tagus River shows that some exotic species are very common and widespread. The loss of the native fish and their replacement by foreign species still appears to be in progress.

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