



## Changes in fish species composition in the middle and lower Tietê River (São Paulo, Brazil) throughout the centuries, emphasizing rheophilic and introduced species

Mudanças na composição de espécies no médio e baixo Rio Tietê (São Paulo, Brasil) através dos séculos, enfatizando espécies reofílicas e introduzidas

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**Abstract: Aim:** This paper is aimed at describing the changes of fish species in the middle and lower courses of the Tietê River, emphasizing rheophilic and invasive fish species as well as identifying the causes for such alterations. **Methods:** Data collection consisted in: intense revision of publications, dissertations and thesis regarding the subject; information at the Zoology Museum at USP (MZUSP); revision in species identification through MUZUSP collection; historical survey of introduced species based on the literature and samplings in the years of 2000 and 2001. **Results:** The main impacts identified in the Tietê River with consequence to the ichthyofauna were: domestic and industrial pollution, deforestation, damming, course rectification, silting and species introduction. From the 80 species identified in the study area, 28 were invasive. Many fish species have been introduced in the Tietê River since the late 19th Century with carpa (*Cyprinus carpio*) being the first one, followed by the introduction of black bass (*Micropterus salmonoides*) at the beginning of 20th Century. Other species such as corvina (*Plagioscion squamosissimus*) have been introduced by electricity companies, which has contributed to the species composition changes. Migratory species as dourado (*Salminus brasiliensis*), pacú (*Piaractus mesopotamicus*) and pintado (*Pseudoplatystoma corruscans*), which used to be abundant have become rare or absent after the construction of reservoirs, mainly because reservoirs in cascade have been built. Piracanjuba (*Brycon orbignyanus*), typically herbivore species, had its stock decreased due to the lack of ciliary vegetation and damming. **Conclusions:** Following the building of the reservoirs there have been important alterations in the composition of ichthyofauna, leading to the nearly complete absence of migratory species and the prevalent species are the ones which adapted to the new conditions. In addition to the damming, lack of ciliary vegetation and pollution also caused alterations in the ichthyological community.

**Keywords:** ichthyofauna; reservoir; environmental impacts; migratory species; invasive species.



**Resumo: Objetivo:** Este trabalho descreve e busca identificar as causas de alterações na composição de espécies de peixes no Médio e Baixo rio Tietê, com ênfase nas espécies reofilicas e invasoras. **Métodos:** Os dados foram obtidos através de uma intensa revisão de publicações, dissertações e teses realizadas na área de estudo, levantamento junto ao Museu de Zoologia da USP (MUZUSP), revisão na identificação das espécies através da coleção do MUZUSP, levantamento histórico de espécies introduzidas e espécies coletadas nos anos de 2000 e 2001. **Resultados:** Os principais impactos identificados no rio Tietê com consequências para a ictiofauna foram: poluição doméstica, poluição industrial, desmatamento, represamentos, retificação do leito, assoreamento e introdução de espécies. Das 80 espécies de peixes identificadas na área de estudo, 28 são invasoras. Diversas espécies de peixes têm sido introduzidas no rio Tietê desde o final do século XIX, sendo a primeira a carpa comum (*Cyprinus carpio*), seguida pela introdução do black bass (*Micropterus salmoides*) no começo do século XX. Outras espécies como a corvina (*Plagioscion squamosissimus*) foram introduzidas por empresas do setor elétrico, o que contribuiu com a alteração da composição de espécies. As espécies migradoras como o dourado (*Salminus brasiliensis*), pacu (*Piaractus mesopotamicus*) e pintado (*Pseudoplatystoma corruscans*) que antes eram abundantes se tornaram raras ou ausentes após a construção dos reservatórios, principalmente por se tratarem de reservatórios em cascata. A piracanjuba (*Brycon orbignyanus*), espécie tipicamente herbívora, teve seu estoque reduzido devido à falta de vegetação ciliar e os represamentos. **Conclusões:** Após a construção dos reservatórios ocorreram profundas alterações na composição da ictiofauna, sendo que espécies migradoras se tornaram praticamente ausentes e as espécies que predominam são as mais adaptadas às novas condições. Além do represamento, a perda da mata ciliar e a poluição também causaram alterações na comunidade íctica.

**Palavras-chave:** ictiofauna; reservatório; impactos ambientais; espécies migradoras; espécies invasoras.

## 1. Introduction

The reservoirs consist in important artificial ecosystems that alter the hydrological and ecological characteristics of a river (Tundisi, 1993), being regulated by the following factors: morphometry, seasoning, operation system, flow rate and residence time. Such factors not only alter the physical and chemical characteristics of the water (Straškraba & Tundisi, 2000; Smith et al., 2014) but also shape the structure of the fish communities (Pelicice et al., 2015). The reservoirs are the dominant environment in the Paraná River Basin and the fish shoals inhabiting these places have been altered from the original ones (Agostinho et al., 1995).

The creation of a new ecosystem, which becomes lentic, somehow constitutes another impact over the remaining communities in the upstream of the damming. This community will suffer modifications such as the reduction of some rheophilic species, which will be replaced by lentic adaptable species, for instance, the Curimatidae (Castro & Arcifa, 1987; Smith & Petrere Júnior, 2001; Agostinho et al., 2008).

In reservoirs there is a change in the composition and structure of fish assembly, leading to a high increase of some species and decrease and even extinction of others. The impact level over the biological diversity is linked to the characteristics of the local fauna, damming location, patterns of circulation, depth and area of the artificial lake, the existence of other dams upstream

and the operational procedures of the reservoir (Agostinho et al., 1995).

Furthermore, the impact over the fish community will depend on several factors, such as the type and size of the river, of great importance, the location and maintenance of vegetal coverage in the margins, the presence of tributaries used for the rheophilic reproduction and the effect of the reservoirs in cascade. Many rheophilic species may survive in the reservoir using the tributaries for reproduction (Smith et al., 2014).

Besides the impacts caused by the construction of reservoirs and their operation, the fish community is subject to several impacts which contribute heavily to the loss of species, as well as the decrease of riparian vegetation, pollution and the introduction of species, which may lead to the reduction of its biomass and abundance and consequently its complete extinction (Smith et al., 2002; Vitule et al., 2009).

There are some studies regarding the composition of the ichthyofauna concerning the Middle and Lower Tietê River. Some examples, Monteiro (1953) evaluated the contribution to the fishery study in the Piracicaba River, and Rocha et al. (2011) described animal invaders in São Paulo state reservoirs. The impacts of the reservoirs and its gradients of middle and lower Tietê, fishing modification due to dam, pollution and the introduction of fish species (Smith et al., 2002, 2003a, 2014; Moretto et al., 2008), and large reservoirs as ecological barriers



The fishes which were captured were fixed in formaline 10% and conserved in alcohol 70%, being stored in plastic recipients and transported to the Núcleo de Estudos de Ecossistemas Aquáticos (NEEA), of the the Centro de Recursos Hídricos e Estudos Ambientais (CRHEA), of the Departamento de Hidráulica e Saneamento (SHS), in the Escola de Engenharia de São Carlos (EESC), Universidade de São Paulo (USP) in São Carlos, São Paulo State, where they were identified using identification keys (Britski, 1972; Britski et al., 1984; Garutti & Britski, 2000). Afterwards, species were confirmed in comparison to the material deposited at the Museum of Zoology at USP, Fish Section.

### 3. Results

The modifications in the Tietê River and its ichthyofauna of throughout the years occurred due to domestic and industrial pollution, deforestation, damming, course rectification, silting and species introduction (Table 1 and Table 2). In the 17th Century, the ciliary forest had already been damaged in the upper course of the Tietê River and more recently the dammings in the middle and lower courses of the Tietê River have strengthened the modification in the composition of fish species. Such impacts caused a series of modifications in the fish population and communities, leading to severe alterations in the composition of species along the Tietê River, as dominance of exotic species and the presence of species that did not occurs previously.

By using data presented in Machado et al. (1968), CNEC (1969) and Nóbrega (1978), it was possible to verify that in the 17th, 18th and 19th Centuries migratory species were common, in addition to the more commonly found species today (Table 3). From the 19th Century on, migratory species

became less abundant in the stretch crossing São Paulo City, causing a simplification of the ichthyofauna.

In the first half of the 20th Century, it was still possible to find migratory species as dourado (*Salminus brasiliensis*), pacú (*Piaractus mesopotamicus*), pintado (*Pseudoplatystoma corruscans*) and piracanjuba (*Brycon orbynianus*) in the stretches of the middle and lower course of the Tietê River, before the constructions of the reservoirs. From the sixties on, because of dams in cascade, such species began to occur in reduced number resulting in the almost complete absence from the eighties on. Nonetheless, curimatá (*Prochilodus lineatus*) and tabarana (*Salminus hilarii*) may still be found in the Tietê River.

Information regarding before the building of the dams is scarce and it may be found in a few papers such as Monteiro's from 1953 about the Piracicaba River but it mentions the Tietê River as far as Barra Bonita reservoir. There are also other studies which date back to the sixties, when the abundance of migratory species such as dourado (*Salminus brasiliensis*), pintado (*Pseudoplatystoma corruscans*), jaú (*Zungaro jahu*) e piracanjuba (*Brycon orbygnianus*) was reported in fishing. Such species became rare after the dammings and recurrent impacts being suffered by the Tietê River. In the Tietê River, from the 80 species which were identified 28 have been introduced (Table 4).

The first introductions in the Tietê River data back to the end of the 19th Century. The first species to be introduced was the carpa (*Cyprinus carpio*). Afterwards, there was the introduction of black bass (*Mycropterus salmoides*), around 1909 in several dams, including the Ponta Nova dam in the upper course of the Tietê River. Imported from Congo,

**Table 1.** Main impacts in the middle and lower courses of the Tietê River and their consequences to the river.

Impact	Consequence on the environment
Domestic pollution	Alteration in water physical and chemical characteristics, nutrient cycling; eutrophication
Industrial Pollution	Alteration in water physical and chemical characteristics.
Deforestation	Erosion, temperature change, and incidence of light, decrease in the environment stability, silting, simplification of aquatic habitats, alteration in the river bed.
Dammings	Alteration in water physical and chemical characteristics.
Course Rectification	Habitat destruction.
Silt removal	Habitat destruction
Introduction of species	Habitat alteration

Based on information from: Moring et al. (1985), Hassel et al. (1998), Beaumord & Petrere Júnior (1994), Barrella et al. (1994, 2000), Johnson et al. (1995), FAO (1997), Stauffer et al. (2000), Matthews (1998), Smith (1999), Smith et al. (2002, 2003a, b) and Barrella & Petrere Júnior (2003).

**Table 2.** Main impacts in the middle and lower courses of the Tietê River and their consequences to the ichthyofauna.

Impacts	Consequence to the fishes	Consequence to the populations and communities
Domestic Pollution	Alteration in the enzymatic activities (causing stress), in activities (swimming), feeding, mucus production and death.	Increase in eggs, young and adult fish death, reduction of abundance, richness and diversity; interference in the distribution of abundance and decrease in the community's complexity.
Industrial Pollution	Alteration in the enzymatic activities (causing stress), in the activities (swimming) feeding, mucus production and death.	Increase in eggs, fingerlings and adult fish death, reduction of abundance, richness and diversity; interference in the distribution of abundance and decrease in the community complexity.
Deforestation	Decrease in feeding resources, shelters and reproduction.	Reduction of abundance, richness and diversity, interference in the distribution of abundance, and decrease in the complexity of the community.
Siltings	Decrease in feeding resources, shelters and reproduction.	Damage in eggs and fingerlings' development.
Dammings	Interference in the migratory species reproduction.	Increase of predation, reduction of abundance, richness and diversity of species, interference in the distribution of abundance and decrease in the community's complexity.
Course Rectification	Decrease in feeding resources, shelters and reproduction.	Increase in the eggs and juveniles' death.
Silt removal	Decrease in feeding resources, shelters and reproduction.	Increase in the eggs and juveniles' death.
Introduction of species	Transmission of diseases and parasites, competition and predation.	Reduction of abundance, richness and diversity, interference in the distribution of abundance, and decrease in the complexity of the community.

Based on information from: Moring et al. (1985), Hassel et al. (1998), Beaumord & Petrere Júnior (1994), Barrella et al. (1994, 2000), Johnson et al. (1995), FAO (1997), Stauffer et al. (2000), Matthews (1998), Smith (1999), Smith et al. (2002, 2003a, b), Barrella & Petrere Júnior (2003), Agostinho et al. (2008, 2016), Rocha et al. (2011) and Pelicice et al. (2015).

tilápias were introduced in São Paulo State in 1952 by São Paulo Light, aiming at populating the dam on the upper part of the Serra do Mar mountain chain. The corvina (*Plagioscion squamosissimus*) was introduced in São Paulo state in 1966 by CESP, in the Pardo River, reaching the Grande River and Paraná River and in Ilha Solteira and Jupia reservoirs, occupying Tietê River (Braga, 1998; Agostinho & Julio Júnior, 1996, 1999; Smith et al., 2003a). Then, tucunaré (*Cichla kelberi*), sardinha (*Triportheus nematurus*), traírao (*Hoplias lacerdae*) and tambaqui (*Colossoma macropomum*), among others. There is no accurate data to be properly informed.

#### 4. Discussion

The main modifications over time in the middle and lower courses of the Tietê River were the reduction of migratory species and the introduction of species. Although there was a change in the fish community, the number of species remained stable throughout the studied period. The dams in the Tietê River prevent the migration of some species, such as jaú (*Zungaro jahu*),

pintado (*Pseudoplatystoma corruscans*) and dourado (*Salminus maxillosus*), among others. These species cannot go upstream and migrate to areas where they can reproduce. Smith et al. (2002), shows a reduction of migratory species caught professionally in the area where Barra Bonita Reservoir is situated. According to Monteiro, in 1953, prior to the dam constructions, a great amount of curimatá (*Prochilodus lineatus*), dourado (*Salminus brasiliensis*), jaú (*Zungaro jahu*) and pintado (*Pseudoplatystoma corruscans*) was caught. In 1989, after the building of the dams, such amount dropped drastically and many of these species disappeared from this river. Agostinho et al. (1999) also noted alterations in the fish catching from 1977 to 1997 in the Paraná River, showing that before the dam constructions, most species present there were migratory, such as *Zungaro jahu*, *Salminus brasiliensis* and *Prochilodus lineatus* and after the damming non-migratory and invasive species as *Pterodoras granulosus* (Valenciennes, 1821), *Plagioscion squamosissimus* and *Hypophthalmus edentatus* were prevailing.

The change in fish community seems to be the main characteristic of damming regions.

**Table 3.** Main fish species captured by fishing (amateur, sports and experimental) in the Tietê River, SP, Brazil, from the 17th Century to the current days.

Species	Common name	Period			
		17th and 18th Centuries	19th Century	20th Century (first half)	20th Century (second half)
<i>Zungaro jahu</i> (Lhering, 1898)	Jaú	X	X	X	
<i>Pseudoplatystoma corruscans</i> (Spix & Agassiz, 1829)	Pintado	X	X	X	
<i>Salminus brasiliensis</i> (Cuvier, 1816)	Dourado	X	X	X	
<i>Salminus hilarii</i> Valenciennes, 1850	Tabarana	X	X	X	X
<i>Piaractus mesopotamicus</i> (Holmberg, 1887)	Pacú	X	X	X	
<i>Brycon orbignyanus</i> (Valenciennes in Cuvier & Valenciennes, 1850)	Piracanjuba	X	X	X	
<i>Hemisorubim platyrhynchos</i> (Valenciennes, 1840)	Jurupoca	X	X	X	
<i>Prochilodus lineatus</i> (Valenciennes, 1836)	Curimbatá	X	X	X	X
<i>Schizodon</i> sp.	Ximborê	X	X	X	X
<i>Astyanax</i> sp. (several species)	Lambari	X	X	X	X
<i>Leporinus</i> sp. (several espécies)	Piava	X	X	X	X
<i>Myleus tietê</i> (Eigenmann & Norris, 1900)	Pacupeba	X	X	X	
<i>Rhamdia quelen</i> (Quoy & Gaimard, 1824)	Bagre	X	X	X	X
<i>Pimelodus maculatus</i> La Cepède, 1803	Mandi	X	X	X	X
<i>Hoplias malabaricus</i> (Bloch, 1794)	Traíra	X	X	X	X
<i>Cyphocharax modestus</i> (Fernández-Yépez, 1948)	Saguiru	X	X	X	X
<i>Steindachnerina insculpta</i> (Fernández-Yépez, 1948)	Saguiru	X	X	X	X
<i>Geophagus brasiliensis</i> (Quoy & Gaimard, 1824)	Cará	X	X	X	X
<i>Serrasalmus maculatus</i> Kner, 1858	Pirambeba			X	X
<i>Plagioscion squamosissimus</i> (Heckel, 1840)	Corvina				X
<i>Moenkhausia intermedia</i> Eigenmann, 1908	Lambari-corinthiano				X
<i>Cichla kelberi</i> Kullander & Ferreira, 2006	Tucunaré				X
<i>Metynnis maculatus</i> (Kner, 1858)	Pacu-prata				X
<i>Satanoperca pappaterra</i> (Heckel, 1840)	Cará				X
<i>Coptodon rendalli</i> (Boulenger, 1897)	Tilápia	X	X	X	X
<b>Number of species</b>		19	19	20	18

Based on information from Monteiro (1953) and Smith et al. (2002, 2003a).

As also observed in the Paraná River by Agostinho et al. (1999), migratory species were abundant in the Tietê River before the damming. Currently non-migratory and introduced species are prevalent. Besides, fishermen emphasize that fish such as dourado and pintado are rarely captured and composition of species in fishing has changed greatly over the last years due to the damming and the introduction of exotic and alien species, increasing the capture of introduced species, wild species and

small-sized species instead of large-sized species which have higher price (Smith, 2006).

The loss of riparian vegetation contributed to the alteration of the species composition, decreasing the piracanjuba population (*Brycon orbignyanus*), since those are typically herbivore. Such loss also resulted in the almost complete disappearance of other species, such as pacú (*Piaractus mesopotamicus*) and pacuzinho (*Myleus tietê*). Along with those impacts it is important to highlight the introduction of species in the Tietê River.

**Table 4.** Species of fish introduced in the middle and lower courses of the Tietê River, SP, Brazil.

Common Name	Species	Origin	Introduction Year	Introduction Place
Black bass	<i>Micropterus salmoides</i> (La Cepède, 1802)	North America	1909	Ponte Nova Damming
Carpa	<i>Cyprinus carpio</i> Linnaeus, 1758	Asia	About 1939	Many rivers in São Paulo state
Tilápia	<i>Coptodon rendalli</i> (Boulenger, 1897)	Africa	1952	Dams on the upper part of the Serra do Mar mountain chain
Tilápia	<i>Oreochromis niloticus</i> (Linnaeus, 1758)	Africa	After 1952	*
Apaiari	<i>Astronotus crassipinnis</i> (Heckel, 1840)	Africa	After 1952	*
Apaiari	<i>Astronotus ocellatus</i> (Agassiz, 1831)	Amazon	After 1938	*
Corvina	<i>Plagioscion squamosissimus</i> (Heckel, 1840)	Amazon	From 1966 on	From the Itapura on (river mouth)
Tucunaré	<i>Cichla kelberi</i> . Kullander & Ferreira, 2006	Amazon	From the eighties on	Reservoirs in the middle and lower courses of Tietê River
Sardinha de água-doce	<i>Triporthus nematurus</i> (Kner, 1858)	Northeast of Brazil	From the eighties on	Reservoirs in the middle and lower courses of Tietê River
Cará	<i>Satanoperca pappaterra</i> (Heckel, 1840)	Amazon	From the eighties on	From the Itapura on (river mouth)
Cará	<i>Geophagus surinamensis</i> (Bloch, 1791)	Amazon	From the eighties on	From the Itapura on (river mouth)
Pacú-prata	<i>Metynnis maculatus</i> (Kner, 1858)	*	From the eighties on	From the Itapura on (river mouth)
Cascudo	<i>Pterygoplichthys anisitsi</i> Eigenmann & Kennedy, 1903	*	From the eighties on	From the Itapura on (river mouth)
Bagre	<i>Trachelyopterus coriaceus</i> Valenciennes, 1840	*	From the eighties on	From the Itapura on (river mouth)
Barbado	<i>Pirirampus pirinampu</i> (Spix & Agassiz, 1829)	Paraná River lower course	Itaipu Reservoir	From the Itapura on (river mouth)
Lambari-bocarra	<i>Roeboides pananensis</i> Pignalberi, 1975	Paraná River lower course	Itaipu Reservoir	From the Itapura on (river mouth)
Caborja	<i>Hoplosternum littorale</i> (Hancock, 1828)	Spread distribution	*	*
Tambaqui	<i>Colossoma macropomum</i> (Cuvier, 1816)	Amazon	*	*
Trairão	<i>Hoplias lacerdae</i> Miranda Ribeiro, 1908	Paraná River upper course	*	*
Cará	<i>Geophagus proximus</i> (Castelnau, 1855)	Amazon	*	Reservoirs in the middle and lower courses of Tietê River
Piauçu	<i>Leporinus macrocephalus</i> Garavello & Britski, 1988	Paraguai River Basin (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Pacu-prata	<i>Metynnis mola</i> Eigenmann & Kennedy, 1903	Paraguai River Basin (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Jeju	<i>Hoplerthrinus unitaeniatus</i> (Agassiz, 1829)	Paraguai River Basin (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Cascudo-preto	<i>Rhinelepis aspera</i> Spix e Agassiz, 1829	Paraguai River Basin (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Jurupecém	<i>Ageneiosus militaris</i> Valenciennes, 1835	Amazon (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Tucunaré	<i>Cichla monoculus</i> Spix & Agassiz, 1831	Amazon (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Tucunaré	<i>Cichla temensis</i> Humboldt, 1821	Amazon (Probably)	*	Reservoirs in the middle and lower courses of Tietê River
Tilápia-branca	<i>Oreochromis mossambicus</i> (Peters, 1852)	Africa	*	Reservoirs in the middle and lower courses of Tietê River

Based on: Machado et al. (1968), CNEC (1969), Monteiro (1953), Smith et al. (2002, 2003a, b), Sazima (2007), Moretto et al. (2008) and Rocha et al. (2011); \*Unknown information.

Agostinho et al. (1992) claimed that in reservoirs there is a change in the composition and structure of fish assembly, featuring excessive increase of some species and decrease or even extinction of others. The clearest response from the fish community in dams was not the disappearance of species but the modification in their structure. Such result is like the one obtained for the Tietê River where several migratory species disappeared. Besides the damming, the loss of species is the result of high deforestation and pollution rates (Smith et al., 2003a). In the Três Irmãos Reservoir it is difficult to catch lambaris, *Astyanax lacustris* Lütken, 1875, *Astyanax fasciatus* (Cuvier 1819) and cará (*Geophagus brasiliensis*), forage species which have nearly disappeared as a consequence of the construction of the reservoir and the pressure caused by the introduced species and the increase of population of other species such as pirambeba (*Serrasalmus maculatus*).

Some species are benefited by damming, as the small-sized ones with fractional spawning, non-migratory and able to use more abundant resources in the reservoirs, such as debris, higher plants, algae and fish. Examples of such species are saguirus (*Cyphocharax modestus* and *Steindachnerina insculpta*) and lambaris (*Astyanax lacustris*, *Astyanax fasciatus*) and *Moenkhausia intermedia* which may be found in the upper course of the Paraná River Basin. These species complete their reproductive cycle in the reservoirs themselves or in their influence area. For these species, there was an increase of the abundance due to the modification in the ecosystem which was lotic and became lentic, making the conditions more favorable (Castro & Arcifa, 1987).

The construction of reservoirs boosted especially the introduction of invasive species from 1960 on. Energy companies were responsible for introducing such species, aiming at improving fishing activity since several native species such as dourado (*Salminus maxillosus*), pintado (*Pseudoplatystoma corruscans*), jaú (*Zungaro jahu*) and piracanjuba (*Brycon orbygnianus*), had had their stocks reduced (Smith et al., 2002, 2003a). It is important to point out that the deforestation of ciliary forest and pollution has also contributed to this reality.

Another aspect to be discussed is that damming eliminates natural obstacles that prevented some fish species to move on to drainage (Pelicice et al., 2015). In Brazil, a typical case refers to the Sete Quedas Falls in the Paraná River. Those waterfalls

were flooded by the Itaipu Reservoir and were no longer an obstacle to the aquatic fauna found in the lower course of the Paraná River. Thus, some species with restricted distribution began to occupy upstream areas following the building of the reservoirs.

In the past, the introduction of species was regarded as an interesting activity to increase commercial fishing. Today though, it is highly agreed that such practice is not advisable, and it may have contributed to the reduction and even disappearance of native species (Hilsdorf & Petrere, 2002). The impacts brought about by exotic and alien species are little known in aquatic Brazilian ecosystems. Despite, information about possible signs of impact may already be found. The tucunará, species from the Amazon, is considered a natural enemy to native species (Rocha et al., 2011) because it caused several species to end in a lake (Zaret & Paine, 1973). Furthermore, tucunará is “good for fishermen”, but extremely damaging to the environment.

There are many negative examples imposed by the introduction of fish species. Amongst them are the loss of species, the reduction of the amount of fish caught and alteration in the environment due to the decrease of spawning areas and even eutrophication (Welcomme, 1988; Fernando, 1991; Ross, 1991; Agostinho & Julio Júnior, 1996; Smith et al., 2003a). Such effect occurs especially when piscivore species are introduced pressuring native species either for predation or for competition. Besides, the introduced species may behave differently from what had been expected, occupying niches that are distinct from their regular ones.

Therefore, the damming in middle and lower courses of the Tietê River caused an important change in fish species composition, since many migratory species are no longer found in these stretches and the species which take advantage from the lentic environment are predominant. Besides all impacts caused by the damming and introduction of exotic species, the middle and lower courses of the Tietê River also suffer with different sources of pollution specially came from the São Paulo city, silting and lack of riparian vegetation. All of those factors contribute to changes in the composition of ichthyofauna throughout the years.

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