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*Research Note*

# Macroparasites of the Invasive Fish, *Cyprinus carpio*, in Patagonia, Argentina

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ABSTRACT: The common carp (*Cyprinus carpio* L.) is probably the most widely distributed freshwater fish species and is cultured on almost all continents. In South America, studies on the parasites from *C. carpio* are limited. The aim of the present study was to report on the macroparasites from wild *C. carpio* populations inhabiting the Neuquen River, which is at the southernmost distribution of *C. carpio* in Argentina. From spring 2011 to winter 2012, four seasonal samples of *C. carpio* were collected from the Neuquen River at the Ingeniero Ballester dam using gill nets. Fish were dissected and all organs were examined using microscopy. All macroparasites were determined and counted and their prevalences and mean intensities calculated. In total, 33 fish were examined and the following six parasites were recorded: the monogeneans *Dactylogyrus extensus* (gills) and *Pseudacolpenteron* sp. (in the canals of the scales along the lateral line system); the cestode *Bothriocephalus* sp. (intestine); the nematode *Contracaecum* sp. (liver and visceral fat); and the acanthocephalans *Pomphorhynchus patagonicus* (intestine and liver) and *Polymorphus* sp. (liver and wall of intestine). The monogenean *D. extensus* was the most commonly encountered species and had the highest prevalence and mean intensity of all parasites detected. This study reports 6 new records of parasite species in *C. carpio* from Argentina.

KEY WORDS: parasites, *Dactylogyrus extensus*, *Pseudacolpenteron* sp., *Bothriocephalus* sp., *Contracaecum* sp., *Pomphorhynchus patagonicus*, *Polymorphus* sp., first record, *Cyprinus carpio*, Patagonia, Neuquen River.

The introduction of species is a potential source of loss of biodiversity and, while competition and predation are the mechanism most studied relative to this phenomenon (Kelly et al., 2009), other factors such as release of parasites from introduced species ("spillover") or the acquisition of local parasites by the introduced species ("spillback") are also important. Spillover can affect native host communities because they have never been exposed to the new parasites and lack defenses against new diseases. Spillback, on the other hand, could increase or diminish parasite populations leading either to amplified infection in native hosts or to the dilution of parasitism by the new host acting as a sink for native parasites (Rauque et al., 2003, 2006; Kelly et al., 2009; Poulin et al., 2011).

The common carp, *Cyprinus carpio* (Linnaeus) is probably the most widely distributed freshwater fish species and is cultured on almost all continents. It is originally from Eurasia and was introduced into central Argentina in 1925 (Zambrano et al., 2006; Rosso, 2007; Cousseau et al., 2010). Nowadays, it is distributed from the northeast of the country through the Rio Negro basin in Patagonia (Fig. 1), which is at the southernmost limit of its distribution. Significantly, this river basin has only recently been colonized by this nonindigenous fish species (Lopez et al., 2002; Alvear et al., 2007; Pérez and Lopez Cazorla, 2009; Cousseau et al., 2010).

Many studies of the parasites of *C. carpio* have been done in North America, where around 163 species of macroparasites infecting this host have been identified, with monogeneans and digeneans the most-represented groups (Margolis and Arthur, 1979; McDonald and Margolis, 1995; Mitchum, 1995; Gibson, 1996; Hoffman, 1999; Salgado-Maldonado et al., 2000; Hudson and Bowen, 2002; Choudhury et al., 2006). In South America, research on the macroparasites from *C. carpio* is limited. In Brazil, studies done on cultured fish (Rego et al., 1999; Schalch et al., 2006) resulted in the detection of an undetermined monogenean species, the cestode *Bothriocephalus acheilognathi* Yamaguti, 1934, and the crustaceans *Lernaea cyprinacea* (Linnaeus, 1758) and *Dolops carvalhoi* Lemos de Castro, 1949. In Peru, the monogenean *Dactylogyrus vastator* Nybelin, 1924 was found in wild fish (Jara and Escalante, 1983), and in Argentina the only parasite recorded from *C. carpio* is *L. cyprinacea* from both cultured and wild fishes (Mancini et al., 2008; Plaul et al., 2010). The aim of the study presented herein was to

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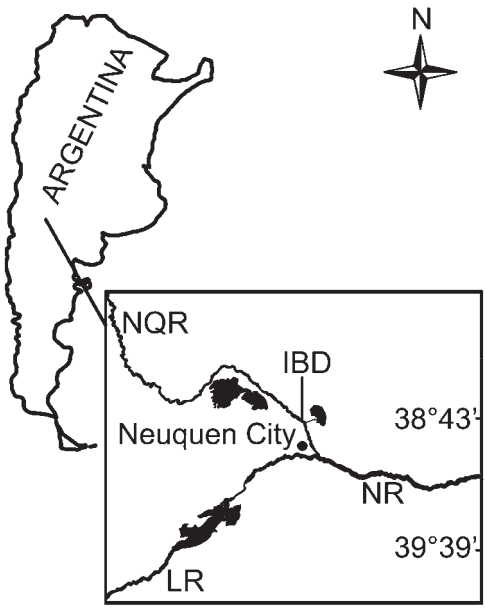



**Figure 1.** Location of Ingeniero Ballester Dam (IBD) in Neuquen River (NQR), Limay River (LR) and Negro River (NR) in Patagonia, Argentina.

report the macroparasites from wild populations of *C. carpio* inhabiting the Neuquen River in Argentina.

The Rio Negro basin is composed of the Limay, Neuquen, and Negro rivers. In the Neuquen River, the Ingeniero Ballester dam (38°43′32″S; 68°10′22″W) is situated approximately 30 km from Neuquen city (Fig. 1) and, through a main channel, supports the irrigation system of Alto Valle region. This region is important as an agricultural and industrial area in Argentina and has a high human population density (Alvear et al., 2007), and human activities associated with this high density have significantly deteriorated the water quality of the rivers (Arribére et al., 2003; Ondarza et al., 2010).

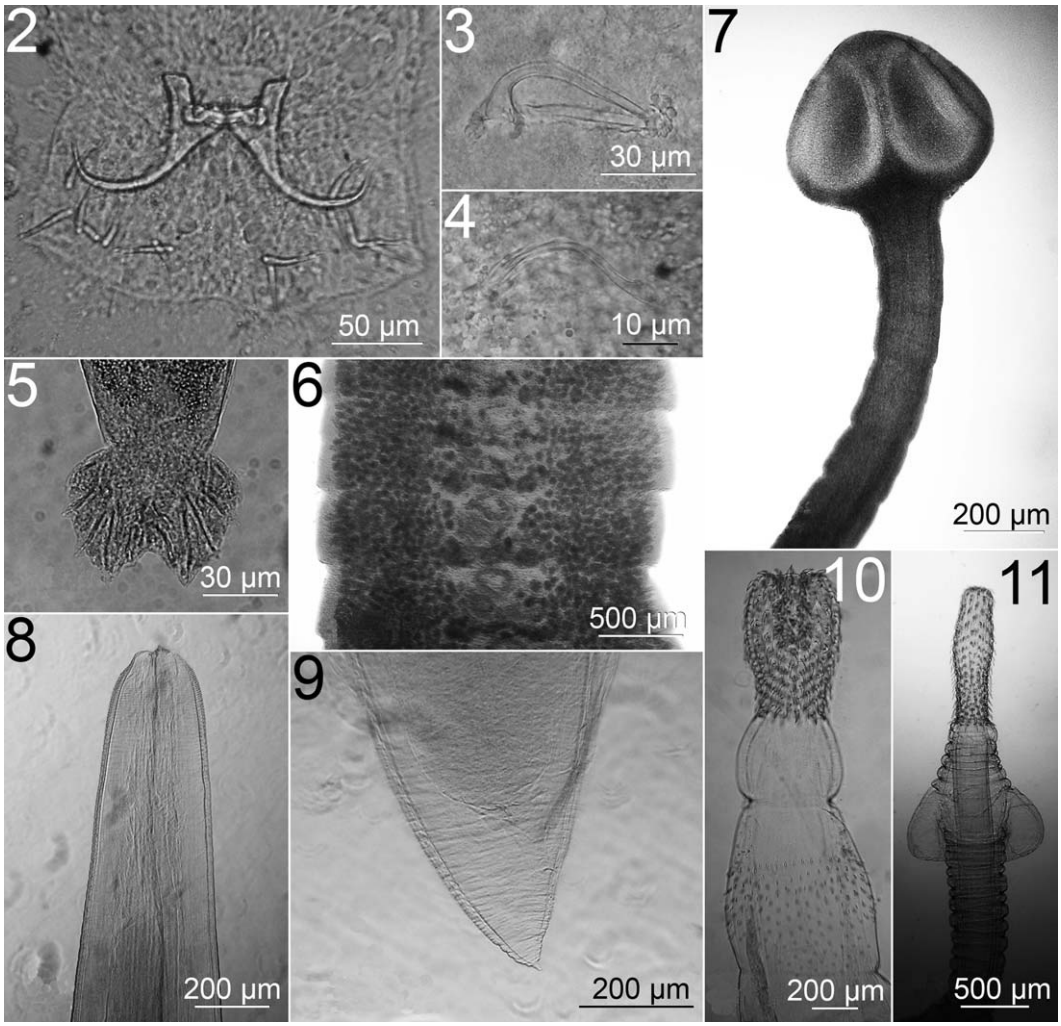
From spring 2011 to winter 2012, 4 seasonal samples of fishes were collected from Ingeniero Ballester dam using gill nets of different mesh sizes. After capture, dead fish were immediately transported to the laboratory on ice. In the laboratory fish were dissected, all organs were checked under the microscope, and parasites were counted and the site of infection recorded. Nematodes and acanthocephalans were fixed in 5% cold formalin. Some specimens of monogeneans were studied alive; others were relaxed in tap water, killed in 1:4,000 formalin, and preserved in 5% cold formalin. Fixed specimens were stained in Gomori trichrome, hydrochloric carmine, or Grenacher carmine-alum and mounted in Canada balsam. Cestodes were fixed in 5% hot formalin and some proglottids were stained with hydrochloric carmine, dehydrated in an ethanol series, cleared in creosote, and mounted in Canada balsam. Some specimens of monogeneans and nematodes were cleared in lactophenol and specimens of each species of macroparasites were preserved in 96% ethanol for future molecular studies. The prevalence and mean intensity of each type of parasite were calculated following Bush et al. (1997). Voucher specimens of the parasites were deposited in the Colección Nacional de Parasitología, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina (MACN-Pa).

In total, 33 fish were examined. From those fish, 6 parasite species were recorded (Table 1, Figs 2–11). These were: the monogeneans *Dactylogyrus extensus* Mueller and Van Cleave, 1932 from gills and *Pseudacolpenteron* sp. in the canals of the scales in the lateral line system; the cestode *Bothriocephalus* sp. in the intestine; the nematode *Contracaecum* sp. in the liver and visceral fat; and the acanthocephalans *Pomphorhynchus patagonicus* Ortubay, Úbeda, Semenas and Kennedy, 1991 (in the intestine and liver) and a *Polymorphus* sp. in the liver and wall of the

**Table 1. Macroparasites recorded in *Cyprinus carpio* ($n = 33$) from the Neuquen River, Argentina.**

| Parasite | Major taxon | Site of infection | Stage* | P ± CI† | MI ± SE‡ |
|---|---|---|---|---|---|
| *Dactylogyrus extensus* | Monogenea | Gills | A | 94 ± 8 | 42.1 ± 8.3 |
| *Pseudacolpenteron* sp. | Monogenea | Canals of lateral line system | A | 3 ± 33 | 4.0 |
| *Bothriocephalus* sp. | Cestoda | Intestine | A | 12 ± 32 | 3.2 ± 1.9 |
| *Contracaecum* sp. | Nematoda | Liver, visceral fat | L | 18 ± 31 | 1.5 ± 0.3 |
| *Polymorphus* sp. | Acanthocephala | Liver, wall of intestine | C | 55 ± 23 | 14.3 ± 7.5 |
| *Pomphorhynchus patagonicus* | Acanthocephala | Intestine, liver | A | 33 ± 28 | 4.2 ± 1.2 |

* A, adult; L, larva; C, cystacanth.
† Prevalence ± 95% confidence intervals.
‡ Mean intensity ± standard error.




**Figures 2–11.** Photomicrographs of *Cyprinus carpio* parasites. **2.** Anchors of *Dactylogyrus extensus*. **3.** Copulatory organ of *D. extensus*. **4.** Copulatory organ of *Pseudacolpenteron* sp. **5.** Anchors of *Pseudacolpenteron* sp. **6.** Mature segments of *Bothriocephalus* sp. **7.** Scolex of *Bothriocephalus* sp. **8.** Anterior end of *Contracaecum* sp. **9.** Posterior end of *Contracaecum* sp. **10.** Protruded proboscis of *Polymorphus* sp. **11.** Protruded proboscis of *Pomphorhynchus patagonicus*.

intestine. *Dactylogyrus extensus* showed the highest values for both prevalence and mean intensity (Table 1). The *Polymorphus* sp. also showed high prevalence values but its mean intensity was low. The least-frequently occurring species was the monogenean *Pseudacolpenteron* sp. (Table 1). Four species (*D. extensus*, *Pseudacolpenteron* sp., *Bothriocephalus* sp., and *P. patagonicus*) were recorded as adults while *Contracaecum* sp. and *Polymorphus* sp. were recorded as larvae (Table 1).

Accession numbers for voucher specimens from *C. carpio* from the Neuquen River are as follows: 2 specimens of *D. extensus* (559/1-2 MACN-Pa); 2 specimens of *Pseudacolpenteron* sp. (560/1-2 MACN-Pa); 2 specimens of *Bothriocephalus* sp. (561/1-2 MACN-Pa); 2 specimens of *Contracaecum* sp. (562/1 MACN-Pa); 3 specimens of *Polymorphus* sp. (563/1 MACN-Pa); and 1 specimen of *P. patagonicus* (564/1 MACN-Pa).

The common carp has a high colonization potential because it is an opportunist with a wide trophic plasticity (Colautti and Lenicov, 2001). This species also has the potential to produce adverse effects on local fish populations and on aquatic environments

due to its method of feeding. In short, sucking the sediment with the mouth increases the turbidity of the water column and relocates solids and nutrients, which can produce changes in both macrophyte and benthic communities (Miller and Crowl, 2006; Rosso, 2007).

Although in South America the common carp has invaded many freshwater environments, to our knowledge only a few studies have focused on its macroparasites in this region, with only 5 parasite taxa reported until now (Jara and Escalante, 1983; Rego et al., 1999; Schalch et al., 2006). In Argentina only *L. cyprinacea* has been recorded (Mancini et al., 2008; Plaul et al., 2010), so the work presented herein increases the number of parasites reported for this fish species to 7 in this country. In North America, 163 species of macroparasites from *C. carpio* have been recorded, with the majority of those parasites being introduced along with carp. However, carp also have the potential to acquire native parasites in the locations they colonize, as is the case with the cestode *Atractolytocestus huronensis* Anthony, 1958, which was originally described from the Huron river in the United States. (Margolis and Arthur, 1979; McDonald and Margolis, 1995; Gibson, 1996; Hoffman, 1999; Choudhury et al., 2006; Paterson et al., 2012).

The salmonid *Oncorhynchus mykiss* (Walbaum), which was introduced into Patagonia as eggs more than 100 yr ago, has since acquired 13 species of native parasites (Ortubay et al., 1994; unpublished data). Meanwhile *C. carpio*, which was introduced in Patagonia about a decade ago, has three native parasite species: *Contracaecum* sp., *Polymorphus* sp., and *P. patagonicus*. Also, *C. carpio* showed a lower overall parasite richness than did *O. mykiss*, which may be expected for such a recently introduced fish. An extensive review done of different freshwater fish species from 10 countries, including Argentina, found that parasite richness was always less in introduced fish species than in native ones (Paterson et al., 2012). Many parasites of carp, including both invasive and potentially pathogenic species, have been introduced on the different continents along with the fish host and nowadays exhibit worldwide distributions (Jeney and Jeney, 1995). For example, the Asian tapeworm *Khawia sinensis* Hsü, 1935, which may cause mortality in young carp, has successfully colonized a large part of Europe, North America, and Asia. However, this parasite has become less common in Europe, possibly as the result of the introduction of another invasive tapeworm, *A. huronensis* from North America (Oros et al., 2004, 2009). Comparisons with parasite fauna of native fishes from Patagonia (Ortubay et al., 1994; Viozzi et al., 2009; unpublished data) allow us to infer that both the 2 monogenean species and the *Bothriocephalus* sp. found in this study were likely introduced along with the carp. Significantly, to our knowledge this is the first report of a *Bothriocephalus* sp. in fishes from Argentina. This parasite may be assigned to *Bothriocephalus acheilognathi*, although molecular studies are necessary to confirm its specific status. Notably, *B. acheilognathi* is one of the most successful invaders of freshwater fish throughout the world (Scholz et al., 2012). Because it is also one of the most pathogenic cestodes of cyprinid fish, *B. acheilognathi* poses a significant threat to native fish populations wherever it is introduced (Velázquez-Velázquez et al., 2011). The rapid spread of this parasite has been aided by the trade of fish for a variety of purposes including aquaculture, aquatic weed control, mosquito control, and as both ornamentals and bait (Scholz et al., 2012).

The monogenean *D. extensus* exhibited the highest values of prevalence and mean intensity in this study, which may be explained by the fact that it does not require an intermediate host and thus may more-readily colonize new environments following introduction.

While the validity of the genus *Pseudacolpenteron* has been controversial (Yamaguti, 1963; Rogers, 1968), specimens of this genus are nevertheless typically localized on either the gills or fins of its hosts (Fayton and Kristky, 2013). As such, the presence of a species of this genus in the lateral line system of fishes from the Neuquen River represents, to our knowledge, a new site of infection for members of this genus. Future studies are needed to know if it represents a previously unidentified species.

*Polymorphus* sp. showed a high prevalence value, which indicates that amphipods are consumed by carps, as this crustacean is the intermediate host of this acanthocephalan species and there are no records of fish consumed by carps in the same river basin (Alvear et al., 2007).

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