

Any colour you like: new records of ornamental livebearers (Poeciliidae: Cyprinodontiformes) from freshwaters of Argentina.

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Abstract

In this note we report the new findings of two species of ornamental poeciliids: *Xiphophorus hellerii*, first record for Argentina, and *Poecilia reticulata*, first record for the Salí River basin and the province of Tucumán, and the second record for Argentina. The swordtails show a very special color pattern and are without doubt individuals from an artificial aquarium strain, not found in natural populations.

Introduction

The family Poeciliidae comprises about 270 valid species (Fricke et al. 2022) occurring naturally in the American Continent, with a remarkable diversity in Central America (Rosen & Bailey 1963; Lucinda 2003) mainly in freshwater and brackish environments, but they also have been reported from saltwater and even hypersaline environments (Trexler 1989). It is characterized by the possession of a gonopodium, formed by a modification of the anal-fin rays 3, 4, and 5 in males (Parenti 1981), and presents several reproductive adaptations including internal fertilization, viviparity by lecithotrophy or matrotrophy, and in *Tomeurus gracilis* only also oviparity (Meffe & Snelson 1989), which allowed the family to invade a great diversity of aquatic ecosystems on almost all the continents (Lowe et al. 2000; Brito et al. 2013, Holitzki et al. 2013). These invasions have been facilitated by their use as ornamental species, and for the biological control of mosquitoes (Chandra et al. 2008; McDowall 1999; Ghosh et al. 2011), like the mosquitofish *Gambusia* introduced worldwide since 1900 (Srean 2015).

The popular consideration is that ornamental species can be a colorful complement to the native (usually almost monochromatic species) fish fauna. Nevertheless, they may compete with native fishes for food resources and habitat, and/or causing its displacement through agonistic behavior or predation (Arthington & Lloyd 1989; Gill et al. 1999; Canonico et al. 2005). Also, alien species can facilitate the spread of diseases and parasites. Considering these threats, an updated record of the introduced species is required in order to protect native fauna.

Poecilia reticulata and *Xiphophorus hellerii* – widely introduced around the globe

Among the family Poeciliidae, *Poecilia* Bloch & Schneider, 1801, is the most diverse genus represented by 75 species (Huber 2019; Fricke et al. 2022), from which the guppy, *Poecilia reticulata* Peters, 1859, is one of the most popular aquarium fish in the world (fig. 22; Lucinda & Van der Sleen 2018). This species is native from Northeastern South America and Trinidad and Tobago, with the type locality in the Guayre River in Venezuela. The native range of this species includes Brazil, Guyana, Surinam (fig. 21), Venezuela, and Trinidad and Tobago (Rosen & Bayley 1963; Bragança et al. 2020). Currently, its presence in natural environments is known to occur in almost 70 countries outside of the species' native range (Deacon et al. 2011). Non-native populations are known from Asia, Africa, Australasia-Pacific, Europe, North America, and South America (GBIF 2016). In South America, *Poecilia reticulata* has been recorded mostly in the northern region of the continent. The presence of this invasive species was confirmed from Paraguay (Lucinda 2017) and Argentina (Rosso et al. 2017), both records from the Paraguay River basin. The capacity of guppies to form large populations within the environment to which it was introduced could

produce an increasing in competition with native fishes for food resources and changing rates of nutrient and/or organic-matter cycling (López-Fuentes et al. 2021).

Species of the genus *Xiphophorus* are native from Belize, Guatemala, Honduras, and especially Mexico. Nevertheless, two species of platies, *X. maculatus* (Günther, 1866) and *X. variegatus* (Meek, 1904), and the swordtail *X. hellerii* Heckel, 1848, have been introduced globally in many different countries and environments. *Xiphophorus hellerii* today is found as an introduced non-native species in self-sustaining populations in over 30 countries, sometimes from multiple introductions in different places as e.g. in several distinct states of Australia or the US (Maddern et al. 2011; Nico et al. 2021). Most of these introductions have happened in areas with tropical or subtropical climate. Yet, the species is also found in colder areas where it has been introduced in thermal waters, as e.g. in Hungary (Pandakov et al. 2021), where it could surely not survive the harsh winters in natural 'unheated' water bodies which may even feature a frozen surface during winter.

In the present contribution we report for the first time the presence of *Xiphophorus hellerii* for Argentina and of *Poecilia reticulata* from Tucumán, Argentina.

Material and Methods

Recent collecting efforts were made in a city park of San Miguel de Tucumán, Tucumán, Argentina (figs. 1-3), where we recorded two introduced species previously unreported.

Fishes were collected with hand nets and the individuals were identified with the taxonomic literature of Kallman et al. (2004), Poeser et al. (2005), and Bragança et al. (2020). DMS-coordinates have been taken from GoogleEarth.



figs. 1, 2 Collection site of both species. Arroyo Bajo Hondo in Parque Guillermina, Salí River basin, Tucumán.

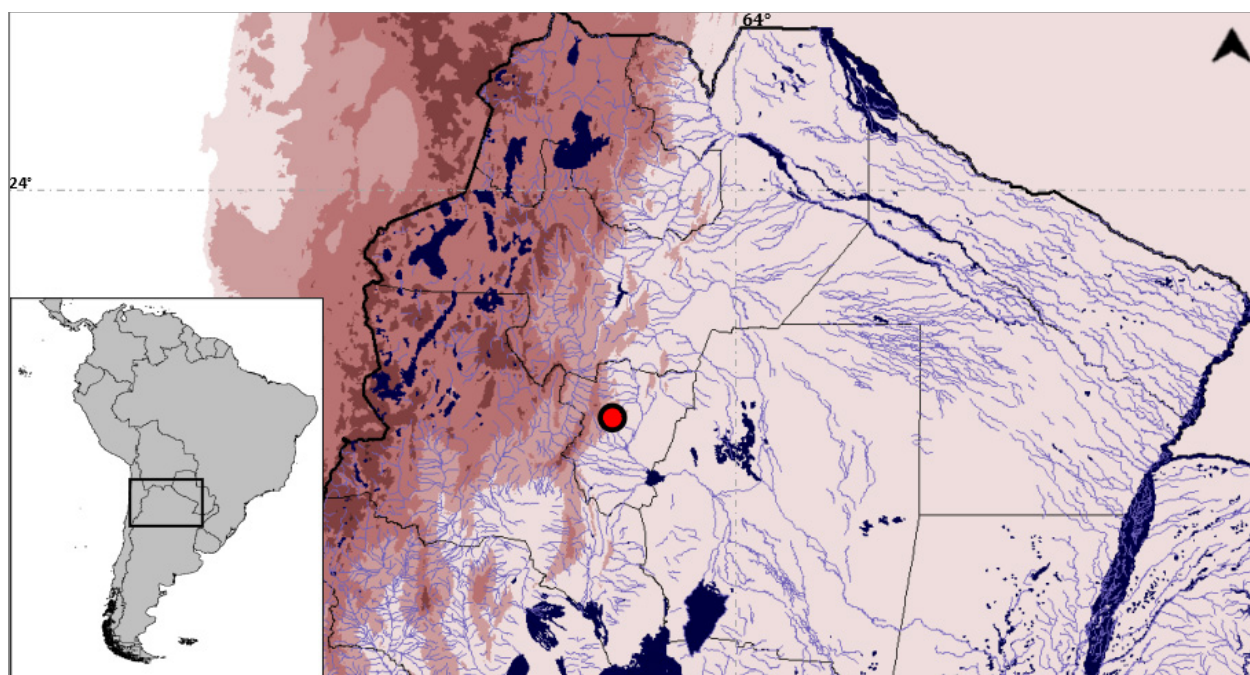


fig. 3 Location of the collection site in the Salí River basin, Tucumán, Argentina. 26°49'21"S, 65°15'30"W.



figs. 4, 5 Two sympatric phenotypes of *Xiphophorus hellerii* males in their natural habitat in Motzorongo, Veracruz, Mexico.



figs. 6, 7
Phenotypes of introduced *Xiphophorus hellerii* from Indonesia (left) and Morocco (above).



figs. 8, 9 Phenotypes of *Xiphophorus hellerii* introduced to the Persis drainage in Iran. Male (left) and female (right).

Results

Xiphophorus hellerii Heckel, 1848 - first record for Argentina

figs. 10-14

Examined material: CI-FML 7807, 4 ex. (1 male, 3 females), 36.1- 40.1 mm SL. Bajo Hondo stream in Parque Guillermina, Salí River basin, Tucumán. 26°49'21"S, 65°15'30"W. Coll.: J.C. Stazonelli & G. Rodriguez, Sep.2020.

The specimens collected present the characteristics which are diagnostic of this species: a medium to large swordtail with a long straight caudal appendage in males. Midlateral stripe dusky. Terminal segment of gonopodial ray 3 produced into a crescentshaped hook and blade pointed distally (figs. 14-15). Ray 4a curves strongly backward over the blade at an angle greater than 90°. Distal serrae of ray 4p reduced in size and number and proximal serrae rather slender. Terminal segment of ray 5a produced into a claw, several times larger than the distal serrae of ray 4p (following Rosen & Bailey 1963; Kallman et al. 2004).

Phenotype 'tuxedo' from Tucumán

The specimens obtained in Tucumán all present a black stripe from the head to the caudal peduncle in the inferior half of the body on a red or green ground color. This color pattern is artificial and the result of selective breeding activities towards more colorful strains for the aquarium hobby. Specimens of wild populations of *Xiphophorus hellerii* from its natural area of distribution (fig. 4) may present black spots, but those are distributed randomly on the body without showing any well-defined pattern (fig. 5). Black patterns in *Xiphophorus* spp. may result in malignant melanomata and develop to skin cancer.



fig. 10 *Xiphophorus hellerii* 'red tuxedo', adult male from Parque Guillermina, Tucumán. 26°49'21"S, 65°15'30"W.



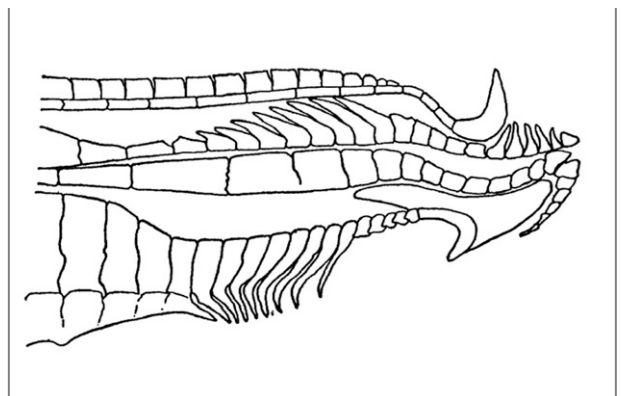
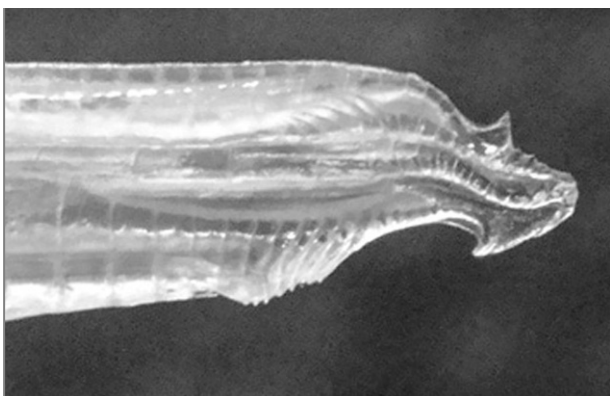
fig. 11 *Xiphophorus hellerii* 'red tuxedo', female, Parque Guillermina, Tucumán. 26°49'21"S, 65°15'30"W.



fig. 12 *Xiphophorus hellerii* 'green tuxedo', female, Parque Guillermina, Tucumán. 26°49'21"S, 65°15'30"W.



fig. 13 *Xiphophorus hellerii* 'red tuxedo', adult male from lot CI-FML 7807.



figs. 14, 15 Gonopodium of *Xiphophorus hellerii* from lot CI-FML 7807 (left) and from fig. 25G of Rosen & Bailey 1963 (right).

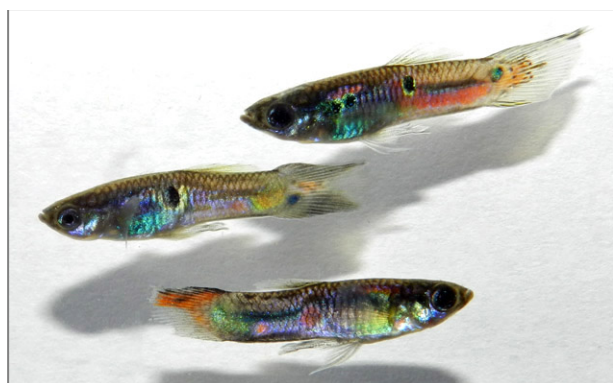
Before having been introduced as genetically stable strains to 'enrichen' the aquarium hobby in 1937, professor Kosswig in 1929 had presented his research on cancer and genetics using *Xiphophorus* spp. as model organisms (Gentzsch 2019). Kosswig's groundbreaking research with *Xiphophorus* is still referred to as the 'Gordon-Kosswig Melanoma System' by specialists from this field. The breed from Tucumán represents a phenotype called 'tuxedo' in the aquarium hobby. This strain was first presented to the public in 1937 as the result of breeding activities in the German city of Wiesbaden (Mombour & Breider 1937). Due to this geographical origin both forms, black stripe on red or green body, were then named 'Wiesbadian strains'. Animals from these strains apparently have been taken to the US very quickly. Until January 1940 this breed was not only available, but had been reproduced already in sufficient quantities to offer 'red tuxedo black' for sale in a price list distributed in the US (EANI 1940). Poeciliids and other livebearing cyprinodontiform species are of broad interest in a specialized branch of the worldwide aquarium hobby. Many aquarium hobbyists interested in livebearers are organized in specialized societies and clubs globally. As these frequently conduct exhibitions and shows with competitions about the 'best' fish, the judges need standardized rules for their evaluation of body form, fins, color etc. 'Tuxedo' is defined by the above mentioned black stripe from head to tail in the lower half of the body, while no black shall be visible on the fins (Gentzsch 2019). The specimens from Tucumán show well defined strains of the red and green bodied varieties of 'tuxedo' (figs. 10-13). That so far no cross-bred specimens presenting red areas on green ground or vice versa have been found could be an indication that this is a relatively young population from a rather recent introduction. The mere presence of 'tuxedo' swordtails in the wild is remarkable, as most other introduced populations from e.g. Indonesia (fig. 6; Ghafari & Fitrianti 2020), Morocco (fig. 7; Mabrouki et al. 2020), Iran (male, fig. 8; Esmaeili et al. 2015), the Iguazú river in Brazil (Larentis et al. 2019), etc. show phenotypes more similar to the wild 'green swordtail' *Xiphophorus hellerii* (fig. 4). Specimens from a population recently found in Turkey (Kirankaya & Ekmekçi 2021) and a female from Iran (fig. 9; Esmaeili et al. 2015) do not show black patterns, but present orange areas on the body and probably also belong to genetically modified strains bred for the aquarium hobby. The same is to be assumed for animals from Australia which show black rays in the caudal fin (Maddern et al. 2011).

***Poecilia reticulata* - first record from the Salí river basin**

figs. 16-19

CI-FML 7808, 12 ex. (6 males, 6 females), 14.2-22.43 mm SL. Bajo Hondo stream in Parque Guillermina, Salí river basin, Tucumán. 26°49'21"S, 65°15'30"W. coll.: J.C. Stazzonelli & G. Rodriguez, Sep.2020.

The specimens collected present the characteristics which are diagnostic of this species: polychromatic and polymorphic colouration pattern in males; gonopodial palp extending beyond gonopodium tip (figs. 19-20); absence of retrorse hook on tip of gonopodial ray 3a; presence of retrorse hook on tip of gonopodial ray 5; gonopodial ray 3 with series of ventral serrae; scales around caudal peduncle 14; and females with 9 anal-fin rays and 6-7 dorsalfin rays. Also, the conspicuous reticulate pattern along the females flank and the absence of a humeral blotch (following Poeser et al. 2005; Bragança et al. 2020).



figs. 16, 17 Males (left) and pair (right) of *Poecilia reticulata* from Tucumán.

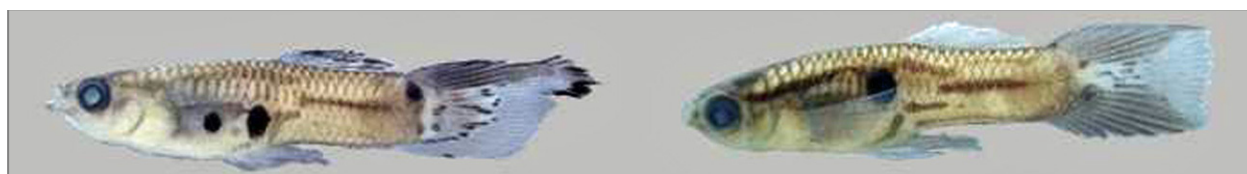
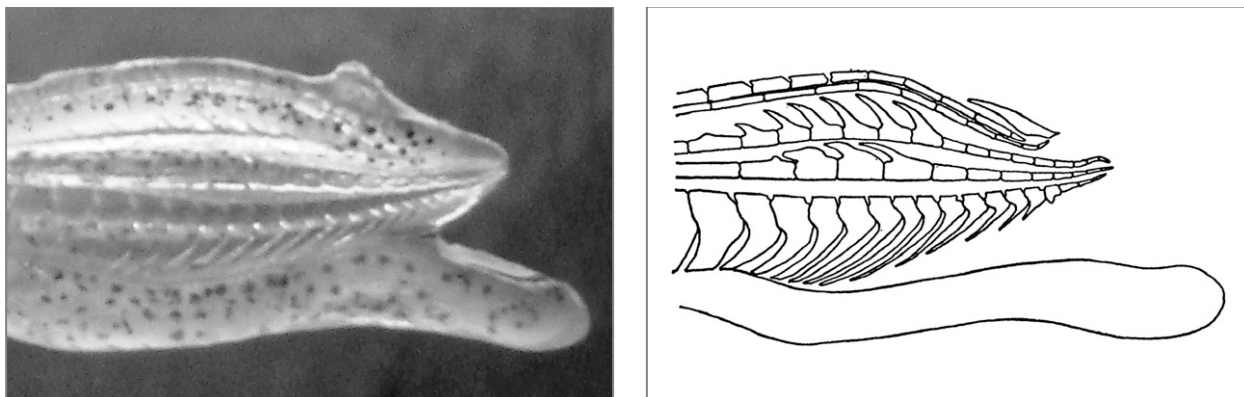


fig. 18 Males of *Poecilia reticulata* from lot CI-FML 7808.



figs. 19, 20 Gonopodium of *Poecilia reticulata* from lot CI-FML 7808 (left) and from fig. 25D of Rosen & Bailey 1963 (right).

Discussion

From the species of fish kept in aquaria, together with the guppy *Poecilia reticulata*, and the goldfish *Carassius auratus*, *Xiphophorus* spp. are probably among the most frequently found in self-sustainable populations out of its natural distribution range populations. In areas where the large-scale breeding of aquarium fishes forms an important industry, as e.g. in Florida or Singapore, many introductions may have been caused by escapes from local aquarium fish farms. Most others are to be blamed on aquarium hobbyists who have dumped their fish to natural habitats. This last scenario is the most probable for the populations of *Xiphophorus hellerii* and *Poecilia reticulata* now found in Tucumán.

There are, so far, at least 26 recorded exotic fish species in Argentinean freshwaters, three of them poeciliids: *Gambusia affinis*, *G. holbrooki*, and *Poecilia reticulata*. Despite that *Poecilia reticulata*, is recorded formally for the first time from this stream in Tucumán, Argentina, this population is established there for at least 35 years surviving the low temperatures of winter (pers.obs. JMM). This is the first record of *Xiphophorus hellerii* for Argentina, of which few specimens were collected. Future sampling studies will be necessary to know if the population is stable and if specimens survive the winter. The geographically closest non-native population of *X. hellerii* from Tucumán is probably the one found in the lower Iguazú river in Brazil (Larentis et al. 2019).

Most introductions of fishes to freshwater bodies have either happened as consequences of escapes from aquaculture facilities, as *Oreochromis* sp., or have been stocked intentionally for the attraction of sport fishing as *Cichla* spp., trouts, salmon, or *Odontesthes bonariensis*, or by the release of left-over alive bait fishes. Also, an important factor is the intentional introduction of the mosquitofish *Gambusia* spp. for fighting malaria.

Comparative material:

CI-FML 7809 *Poecilia reticulata*, 74 ex., Caroni river in Chaguanas, Chaguanas, Borough state, Caroni river. Trinidad and Tobago. Coll.: G. Aguilera & J. Torres-Dowdall, Mar.2011.



fig. 21
Poecilia reticulata, wild male, phenotype from Suriname, within the natural range of distribution

fig. 22
Poecilia reticulata, variety of males from different strains as probably sold in every aquarium shop around the globe



Future prospects of the swordtails in Tucumán

Despite the fact that the discovery of a new population of a non-native species is always bad news, science can take advantage of its presence regardless. Especially the easy access in the centre of a city and the possibility of easy collecting in this little stream may make the population of *Xiphophorus hellerii* in Tucumán a favored subject of investigation. Any research program treating with ecology and/or population dynamics may try to answer the following questions:

- Is the population density growing or shrinking? If so, is it related to the highest and/or lowest temperatures during the year?
- Is the population staying limited to its actual range of distribution or spreading?
- As both, red and green individuals, are present in this gene pool, can any shift towards either color be observed?
- As green is supposed to be a better camouflage than red, it may be an advantage to be green for both rolls, the one of being a prey and the one of being a predator. Can a difference be observed in the stomach contents of red or green individuals at different ages? Does the stomach content of predators show a preference on either red or green? Are there differences between the predatory species?
- In the rolls of prey or predator is there a difference between guppies and swordtails?

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