

Genus *Phalloceros* Eigenmann, 1907: list of species and peculiarities

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Abstract. In this study, we propose to present the list of species, geographic distribution, and the particularities of the genus *Phalloceros*. Genus *Phalloceros* is an interesting and distinctive group of fish within the diverse family Poeciliidae. The genus is native to Brazil, Paraguay, Uruguay and northern Argentina. There are currently 22 recognized species in this genus, of which 21 were described in 2008. *Phalloceros* species are freshwater fish found in various habitats such as streams, rivers, and swamps. They are omnivorous, like many other poeciliids, but have a preference for algae and plant material. This may be related to their habitat preferences and the availability of these food sources in their natural environment. *Phalloceros* species are livebearers, meaning they give birth to live young instead of laying eggs. This type of reproduction is common among poeciliids, but *Phalloceros* males have unique modifications to their reproductive anatomy that allow for more efficient sperm transfer during mating.

Key Words: gonopodium, invasive potential, *Phalloceros*, poeciliidae, species list.

Introduction. *Phalloceros* is a genus of freshwater fish that belongs to the family Poeciliidae, which includes other livebearing fishes like guppies, swordtails and mollies (Miller et al 2010; Petrescu-Mag et al 2013; Gavrioloie et al 2016ab). The genus *Phalloceros* is native to South America (Brazil, Paraguay, Uruguay and northern Argentina) and includes a number of 22 valid species (Thomaz et al 2019) found in various habitats such as streams, rivers, and swamps.

These fish are relatively small, usually reaching only 2-3 inches (5-8 cm) in total length, and are popular among hobbyists for their attractive colors and easy-to-care-for nature. They are known for their livebearing reproduction, which means they give birth to live young instead of laying eggs (McNeil & Wilson 2008).

Phalloceros species are omnivorous and feed on a variety of foods, including small aquatic invertebrates, algae, and other plant material (McDowall 1999; Morgan et al 2004; Wolff et al 2007; Mazzoni et al 2010). They are also known to be adaptable to different water conditions and can be kept in a wide range of aquarium setups.

In this work, we propose to present the list of species, geographic distribution, and the particularities of the genus *Phalloceros*.

Etymology. The name "Phalloceros" is composed of two ancient Greek words: "phallos", which means penis, and "keras", meaning horn, referring to the gonopodium of the males from the genus (Romero 2002, cited by Froese & Pauly 2022).

Peculiarities. There are several peculiarities that set the genus *Phalloceros* apart from other poeciliids, as presented below. These peculiarities make *Phalloceros* an interesting and distinctive group of fish within the diverse family Poeciliidae.

The gonopodium structure. The males of the *Phalloceros* genus have a unique structure known as a "modified anal fin", or gonopodium, which is used for mating. The

gonopodium is longer and more complex in *Phalloceros* than in other poeciliids, and has been the subject of much study due to its elaborate and varied shapes (Thomaz et al 2019).

Habitat. While many poeciliids are found in a variety of freshwater habitats (Petrescu-Mag 2007a, 2008), *Phalloceros* species are typically found in small, shallow streams and swamps in South America. They are often associated with aquatic vegetation and other forms of cover (Aranha et al 1998; McNeil & Wilson 2008; Mazzoni et al 2010).

Diet. *Phalloceros* are omnivorous, like many other poeciliids, but have a preference for algae and plant material (de Almeida Monaco et al 2014). This may be related to their habitat preferences and the availability of these food sources in their natural environment.

Reproduction. *Phalloceros* species are livebearers, meaning they give birth to live young instead of laying eggs (de Almeida Monaco et al 2014). This mode of reproduction is common among poeciliids (Petrescu-Mag et al 2019; Oroian & Kovacs 2022), but *Phalloceros males* have unique modifications to their reproductive anatomy that allow for more efficient sperm transfer during mating (Dos Santos & de Britto 2021).

Invasive Potential. There is limited information available on the invasive potential of *Phalloceros* species, as they are not commonly kept or traded in the aquarium trade and are not widely distributed outside of their native range. However, like many other poeciliids (Păsărin et al 2007; Mag et al 2009), some *Phalloceros* species may have the potential to become invasive if introduced to new habitats outside their natural range.

For example, *Phalloceros caudimaculatus* (Hensel, 1868) (Figures 1 and 2), also known as the dusky millions fish, has been introduced to some freshwater habitats in Australia (Rayner & Creese 2006), where it is considered an invasive species (Rowley et al 2005; McNeil & Wilson 2008). The species is known to compete with native species for resources and may also (at least hypothetically) hybridize with other closely related poeciliids that are present in these habitats.

While the invasive potential of *Phalloceros* species is not well-studied, it is possible that they could become a problem if introduced to new habitats outside their native range. Therefore, it is important to prevent the release or escape of aquarium fish into natural waterways and to follow responsible aquarium practices to minimize the risk of unintentional introductions (Iacob & Petrescu-Mag 2008).



Figure 1. *Phalloceros caudimaculatus* - wild phenotype (photo: Lucas-Attwell for wikipedia.org). The correct determination of the species is uncertain given the taxonomic reorganization within the genus that took place in 2008. Photo may be older than 2008.



Figure 2. *Phalloceros caudimaculatus* – spotted melanic phenotype (photo: Kjell Nilsson for fishbase.org) (Froese & Pauly 2022). The correct determination of the species is uncertain given the taxonomic reorganization within the genus that took place in 2008. Photo may be older than 2008.

List of Species and Geographic Distribution. The data presented below was compiled from Froese & Pauly (2022). There are currently 22 recognized species in this genus:

Phalloceros caudimaculatus (Hensel, 1868) (dusky millions fish). They are distributed in South America: Rio de Janeiro, Brazil southward to Uruguay and Argentina (Lopez et al 1987). They were introduced mainly for mosquito control (Welcomme 1988). At least one country reports adverse ecological impact after introduction (Rowley et al 2005).

Phalloceros alessandrae Lucinda, 2008. They are distributed in South America: Brazil, in flooded areas on margins nearby Antonina and rio Dois de Fevereiro, flowing into the Baía de Paranaguá.

Phalloceros anisophallos Lucinda, 2008. They are distributed in South America: Brazil in the drainages of rio Parati, rio Barra Grande, rio São Roque, rio Taquari and rio Itinguçu (small coastal drainages of Rio de Janeiro).

Phalloceros aspilos Lucinda, 2008. They are distributed in South America: Brazil: Rio Parati-Mirim, Rio de Janeiro (Lucinda 2008).

Phalloceros buckupi Lucinda, 2008. They are distributed in South America: Rio Jacareí drainage and neighbouring, which flows into the Baía de Paranaguá in Paraná, Brazil.

Phalloceros elachistos Lucinda, 2008. They are distributed in South America: Brazil: Drainages of rio Doce, Santa Maria da Vitória, Jucu, and Timbuí, coastal drainages of Espírito Santo State of Brazil.

Phalloceros enneaktinos Lucinda, 2008. They are distributed in South America: known only from the type locality in the Córrego da Toca do Boi, Rio de Janeiro, Brazil.

Phalloceros harpagos Lucinda, 2008. They are distributed in South America: Rio Paraná-Paraguay basin and coastal drainages from Rio Itaboapana to Rio Araranguá.

Phalloceros heptaktinos Lucinda, 2008. They are distributed in South America: known only from tributaries of the arroio dos Ratos, Jacuí basin in Rio Grande do Sul, Brazil.

Phalloceros leptokeras Lucinda, 2008. They are distributed in South America: Brazil: middle portions of Rio Paraíba do Sul drainage (Lucinda 2008).

Phalloceros leticiae Lucinda, 2008. They are distributed in South America: upper Rio Araguaia, main tributary to the Rio Tocantins in Brazil.

Phalloceros lucenorum Lucinda, 2008. They are distributed in South America: Rio Juquiá, a tributary to the drainage of the Rio Ribeira de Iguape in São Paulo, Brazil.

Phalloceros malabarbai Lucinda, 2008. They are distributed in South America: known only from type locality, creek near Itapoá, São Francisco do Sul, Santa Catarina, Brazil.

Phalloceros megapolos Lucinda, 2008. They are distributed in South America: Brazil in the drainages of the Rio São João, rio Cubatão (Norte) and small adjacent drainages, which flows into the Baía de Guaratuba in Paraná State.

Phalloceros mikrommatos Lucinda, 2008. They are distributed in South America: Rio João de Tiba drainage in Bahia, Brazil.

Phalloceros ocellatus Lucinda, 2008. They are distributed in South America: coastal drainages between Prado and Sooretama in Brazil.

Phalloceros pellos Lucinda, 2008. They are distributed in South America: small coastal drainages flowing into Baía de Paranaguá in Paraná State, Brazil.

Phalloceros reisi Lucinda, 2008. They are distributed in South America: headwaters of Rio Tietê, Rio Paraíba do Sul, Rio Ribeira de Iguape, and small coastal drainages in São Paulo, Brazil.

Phalloceros spiloura Lucinda, 2008. They are distributed in South America: Brazil in Rio Iguaçú and coastal drainages of Rio Grande do Sul and Santa Catarina, including the Rio Tubarão, Rio Itajaí-Açu, Rio Itapocu, Rio Mampituba, Rio Cubatão (North), Rio Tramandaí drainages.

Phalloceros titthos Lucinda, 2008. They are distributed in South America: coastal drainages flowing to Baía de Guaratuba and Baía de Paranaguá in Paraná, Brazil.

Phalloceros tupinamba Lucinda, 2008. They are distributed in South America: Rio Itamambuca and Rio Macacu drainages, small coastal drainages of São Paulo and Rio de Janeiro States of Brazil.

Phalloceros uai Lucinda, 2008. They are distributed in South America: Rio das Velhas, Rio São Francisco basin in Brazil.

Regarding the studies carried out before 2008 and published in the literature, we cannot know precisely which species the studies refer to, because *Phalloceros* populations had a different taxonomic classification before 2008 than they have today.

Melanic Phenotypes. Some species within this genus exhibit a dark pigmentation pattern known as melanic phenotype. Melanism is a genetic trait that causes an increase in the production of dark pigments, such as melanin, in an organism's skin, fur, or feathers (Mag & Bud 2006; Petrescu-Mag 2007b; Yenmiş et al 2022). In *Phalloceros*, the melanic phenotype is characterized by a dark or black coloration on the skin, fins, and scales of the fish (Figure 2). Melanism can be a beneficial trait in certain environments, as it can provide camouflage from predators (Petrescu-Mag et al 2008) or stress resistance (Svitačová et al 2023). Melanism can be also detrimental for health in some cases (Petrescu-Mag & Proorocu 2022).

In *Phalloceros*, the presence of the melanic phenotype has been observed in different species, including *P. caudimaculatus*, *P. harpagos*, and *P. reisi* (personal observation). The genetic basis of this trait is not well understood in *Phalloceros*, but it is believed to be influenced by multiple genes (Campagna et al 2022). The melanic phenotype in *Phalloceros* is an interesting area of research for understanding the genetic and ecological factors that influence coloration in animals.

Conclusions. Genus *Phalloceros* is an interesting and distinctive group of fish within the diverse family Poeciliidae. The genus is native to Brazil, Paraguay, Uruguay and northern Argentina. There are currently 22 recognized species in this genus, of which 21 were described in 2008. *Phalloceros* species are freshwater fish found in various habitats such as streams, rivers, and swamps. They are omnivorous, like many other poeciliids, but have a preference for algae and plant material. This may be related to their habitat preferences and the availability of these food sources in their natural environment. *Phalloceros* species are livebearers, meaning they give birth to live young instead of laying eggs. This type of reproduction is common among poeciliids, but *Phalloceros* males have unique modifications to their reproductive anatomy that allow for more efficient sperm transfer during mating.

Conflict of Interest. The authors declare that there is no conflict of interest.

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Received: 04 December 2022. Accepted: 18 December 2022. Published online: 30 December 2022.

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How to cite this article:

Oroian I., Balint C., Păpuc T., 2022 Genus *Phalloceros* Eigenmann, 1907: list of species and peculiarities. Poec Res 12(1):39-45.