

New records of *Physa acuta* (Gastropoda: Physidae) and the ectoparasite *Chaetogaster limnaei* (Oligochaeta: Naididae) in central Chile

Nuevos registros de *Physa acuta* (Gastropoda: Physidae) y el ectoparásito *Chaetogaster limnaei* (Oligochaeta: Naididae) en Chile central

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ABSTRACT

The sewage snail *Physa acuta* has invaded several countries worldwide. Its presence in Chile was first reported in 2014. Recently, this species was recorded for the first time in the Bullileo Reservoir, central Chile, in association with the oligochaete *Chaetogaster limnaei*, which was found within the mantle cavity of the snail. The presence of juvenile and adults of *P. acuta* greater than 10 mm suggests that the species is well adapted to the ecosystem. A prevalence of 39.1% of *C. limnaei* was recorded for *P. acuta*, with a range of infestation of 1–4 parasites per host.

Keywords: Bullileo reservoir, ectoparasitoid, invasive species, Maule Region, taxonomy.

RESUMEN

El caracol de aguas residuales *Physa acuta* ha invadido varios países del mundo. La introducción de esta especie en Chile se informó por primera vez en 2014. Recientemente, esta especie fue registrada por primera vez en el embalse Bullileo, centro de Chile, en asociación con el oligoqueto *Chaetogaster limnaei*, que se encontró habitando la cavidad del manto del caracol. La presencia de juveniles y adultos de *P. acuta* de tamaño superior a 10 mm sugiere que la especie está bien adaptada al ecosistema lacustre. Se registró una prevalencia del 39,1% de *C. limnaei* sobre *P. acuta*, con un intervalo de infestación de uno a cuatro gusanos por hospedador.

Palabras clave: Embalse Bullileo, ectoparasitoide, especies invasoras, Región del Maule, taxonomía.

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INTRODUCTION

The gastropod family Physidae are air-breathing freshwater snails having a holarctic distribution, extending into Central America and part of South America (e.g. Paraense 1987, 2003, 2005, Wethington and Lydeard 2007, Collado 2017). However, with the introduction of *Physa acuta* Draparnaud, 1805 in Africa, as well as the Southern Cone of South America, Europe, Australia and Asia, physids are now commonly found worldwide (Miquel 1985, Miquel and Zelaya 1999, Dillon *et al.* 2002, Appleton 2003, Núñez and Pelichotti 2003, Paraense 2005, Collado 2017).

Classification of physids has been historically difficult, with over 40 nominal species attributed to different genera (Wethington *et al.* 2022). However, the simple two-genus system, *Physa* Draparnaud, 1801, and *Aplexa* Fleming, 1820, seems to be appropriate for the family (Dillon 2022, Wethington *et al.* 2022). In the present study, we consider the physid species as *Physa acuta* following several taxonomic and systematic studies (e.g. Wethington and Lydeard 2007, Bousset *et al.* 2014, Ebbs *et al.* 2018, Dillon 2022, Wethington *et al.* 2022).

Traditionally, five native species of *Physa* have been recognized in Chile: *Physa chilensis* Claessin, 1886, *Physa nodulosa* Biese, 1948, *Physa peruviana* Gray, 1828, *Physa porteri* Germain, 1913 and *Physa rivalis* Sowerby, 1874 (Stuardo 1961, Valdovinos 1999, 2006, Sielfeld 2001). To this fauna must be added the invasive species *P. acuta* which was first documented in this country in 2014 and later in 2017, 2019, 2020 and 2023 (Bousset *et al.* 2014, Collado 2017, Collado *et al.* 2019, 2020, 2023). However, it is possible that *P. acuta* has been introduced to Chile much earlier, as individuals of this species were found in the type locality of *P. nodulosa*, suggesting a possible synonymy (Collado 2017). *Physa venustula* Gould, 1847 has also been cited for Chile by some foreign authors (Núñez and Pelichotti 2003, Taylor 2003), but Araya (2015) classifies it as cryptogenic or dubious species. On the other hand, Letelier *et al.* (2007) considered *P. venustula* as an introduced species in the country.

The oligochaete genus *Chaetogaster* Baer, 1827 is common in freshwater environments where it can associate with different aquatic invertebrates worldwide (Brinkhurst and Jamieson 1971, Callisto *et al.* 2005). Previous studies have reported a commensal or parasitic relationship of *Chaeto-*

gaster limnaei Baer, 1927 with gastropods and bivalves (Gruffydd 1965a,b, Buse 1974, Streit 1974, Barbour 1977, Gamble and Fried 1976, Gelder 1980, Conn *et al.* 1996, Ibrahim 2007). In Chile, *C. limnaei* was for the first time found associated with *P. acuta* (Collado *et al.* 2019), constituting the second record for the country of a *Chaetogaster* species after *Chaetogaster diastrophus* (Gruthuisen, 1828), cited from the Chilean Altiplano (SINAB 2017). On the other hand, Fuentealba Jara (2011) reported for the first time specimens of *Chaetogaster* sp. associated with snails of the genus *Uncancylus* Pilsbry, 1913.

The aim of this study was to report the occurrence of *P. acuta* from Bullileo Reservoir in Maule Region, central Chile, and to evaluate the presence of *C. limnaei* in the mantle cavity of this snail.

MATERIALS AND METHODS

Twenty-three specimens of *Physa acuta* were collected in 2017 from the Bullileo reservoir (36°17'42.10" S, 71°24'35.09" W) (Fig. 1). Bullileo reservoir is an artificial lake created for agricultural irrigation located about 50 km east of Parral city in the Maule Region. The reservoir is relatively isolated from human influence on the western edge of the Andes Mountain range, although in the warmer months it is used for sport fishing and recreation. The environment is made up of hills covered by exuberant native vegetation. On the shore of the lake, it is possible to find stones and abundant macrophytes that harbor snails. *Physa acuta* was identified using shell characters, soft body characters and anatomy of the reproductive system (see Collado 2017). The shell and soft body of the snails were photographed using a stereomicroscope (Motic). *Chaetogaster* specimens were isolated by microdissection of the snails and photographed with a light microscope (Motic). Worm images were also obtained using a Hitachi SU3500 scanning electron microscope (SEM). The *Chaetogaster* worms were identified as *C. limnaei* based on Collado *et al.* (2019), taxonomic keys and anatomical descriptions from various sources (Brinkhurst 1971, 1986, Kathman and Brinkhurst 1998, Cichy *et al.* 2016, Gelder 1989, Gruffydd 1965a,b, Khalil 1961). Voucher specimens are deposited at the Laboratorio de Malacología y Sistemática Molecular, Universidad del Bío-Bío, Chillán, Chile (LMSM UB-BCC-*Chaetogaster limnaei* 1,2,8; LMSM UB-BCC-*Physa acuta* 1,7,9).

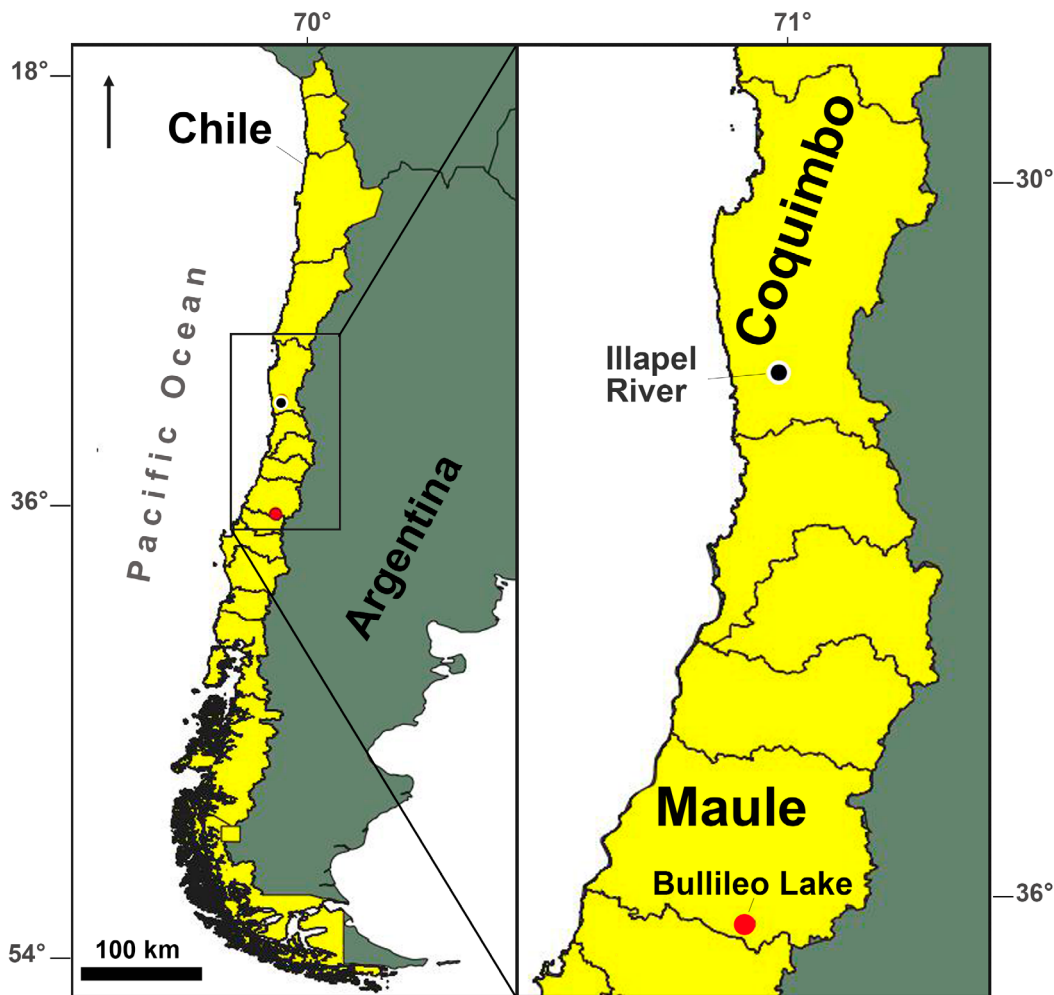


Figure 1. Sample site of snails and oligochaetes performed in the present study in Bullileo Reservoir, Maule Region, Chile (red circle). A first finding of *Chaetogaster limnaei* on *Physa acuta* in Illapel River, Coquimbo Region, is also indicated (black circle) (Collado et al. 2019).

RESULTS

We identified physid specimens from the Bullileo reservoir as *Physa acuta* (Fig. 2). They were characterized as follow: shell elongate-ovate (2.0 to 10.1 mm), light brown-translucent, thin and without ornamentations (Fig. 2a). Mantle black with irregular large grayish-white spots (Fig. 2b) and two digitated lobes, one on each side of the body. Foot-head gray, with irregular small black spots. Penial complex (Fig. 2c) composed by the prepuce, penis sheath, and penis. Prepuce with a conspicuous lentil shaped gland on the proximal section of the preputial wall (Fig. 2c). Penis sheath enclosing the penis. Penis elongated, pointed, with the widest, rounded distal end (Fig. 2d); it is white in color.

Of the 23 individuals of *P. acuta* examined, nine of them contained individuals of *Chaetogaster limnaei* (Fig. 3a), accounting for 39.1% prevalence. The worms isolated in

a petri dish supplied with fresh water were quite active, stretching and shrinking rapidly, making it difficult to estimate size. However, two specimens measured 500 and 530 μm , respectively. The worms were characterized by having a discrete prostomium and clusters of setae (bristles) on their ventral side (Fig. 3b-d). These clusters were unevenly distributed throughout the body. They were frequent in the mid-posterior part of the body, but not in the anterior end, lacking setae, except for a couple of clusters developed at the level of the pharynx. Internally, by stretching the body, the worms also stretch the stomach and intestine, which then shrink. A pharynx was observed after the mouth. In some cases, the worms could be seen through the shell moving in the mantle cavity. The range of infestation varied from one up to four worms per snail. The smallest snail with worms measured 2.0 mm, containing three worms.

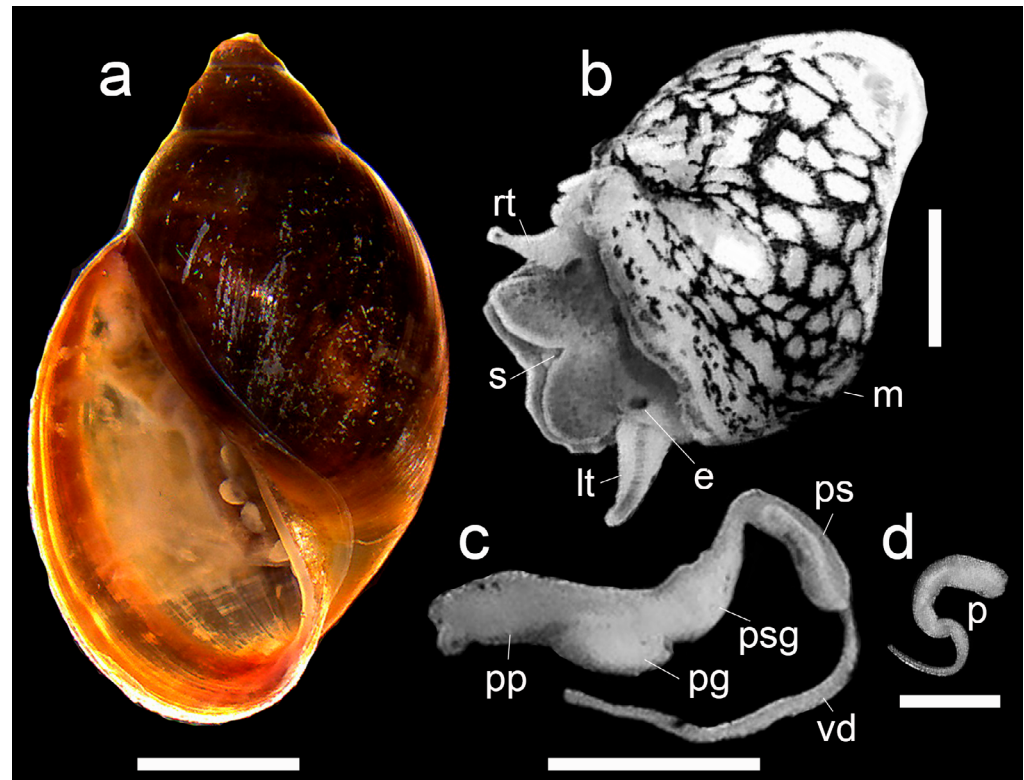


Figure 2. *Physa acuta* from Bullileo reservoir, Maule Region, Chile. **a.** Shell. **b.** Soft body (anterior). **c.** Penial complex. **d.** Penis. e= eye, lt= left tentacle, m= mantle, p= penis, pg= preputial gland, pp= prepuce, ps= penis sheath, psg= penis sheath gland, rt= right tentacle, s= snout, vd= vas deferens. Scale bar **a**= 2 mm; **b, c**= 1 mm; **d**= 0.5 mm.

DISCUSSION

The native range of *Physa acuta* was long uncertain. Some authors conceived the species as native to Europe (Burch 1988, see also Fofonoff *et al.* 2020) and in fact, it was originally described from the Garonne River, France, in 1805. Similarly, Johnson *et al.* (2013) indirectly considered *P. acuta* as non-native to North America in their revision of the conservation status of native gastropods from the region because they did not include it in the list (Lydeard *et al.* 2016). On the other hand, it was also suggested that the species could be native to North America (Brown 1980). However, the absence of fossils of *P. acuta* in Europe, in addition to studies of reproductive isolation, reproductive anatomy and molecular analyzes indicate that the species should be considered native to North America (Dillon *et al.* 2002, Anderson 2003, Paraense and Pointier 2003, Czaja *et al.* 2014, Lydeard *et al.* 2016, Ebbs *et al.* 2018, Morningstar and Daniel 2020).

At present, *P. acuta* can be found in all continents except Antarctica (Wethington and Lydeard 2007, Bousset *et al.* 2014). Several authors have shown that this invasive species has replaced populations of native snails of different genera (Dobson 2004, de Kock and Walmarans 2007,

Gashaw *et al.* 2008), being able to alter the interactions between members of the community (Paul *et al.* 2021). In Chile, the invasive range of *P. acuta* extends from Elqui River, Coquimbo Region to Puerto Chico, next to Puerto Varas in Llanquihue Lake, Los Lagos Region, encompassing more than 1000 km of invaded area (Bousset *et al.* 2014, Collado 2017, Collado *et al.* 2019, 2020, 2023). The present record of the species is added to that recently found in the Maule River for a species of Physidae (Collado and Fuentealba 2020).

It has been reported a commensal association between *C. limnaei* with gastropods and bivalves (Gruffydd 1965a,b, Buse 1974, Streit 1974, Barbour 1977, Gelder 1980, Conn *et al.* 1996, Ibrahim 2007). However, Stoll *et al.* (2013) showed that individuals of *P. acuta* grew more slowly and presented lower reproductive output after infection with *C. limnaei*. These results agree with previous studies that considered *C. limnaei* to be a true parasite (Michelson 1964, Gamble and Fried 1976). On the other hand, Mitchell and Leung (2016) found a positive correlation between the size of *P. acuta* and the infection intensity of *C. limnaei* suggesting that snails will be more affected as they grow.

Considering differences in habitat and diet, it was proposed the subspecies *Chaetogaster limnaei vaghini* Gruff-

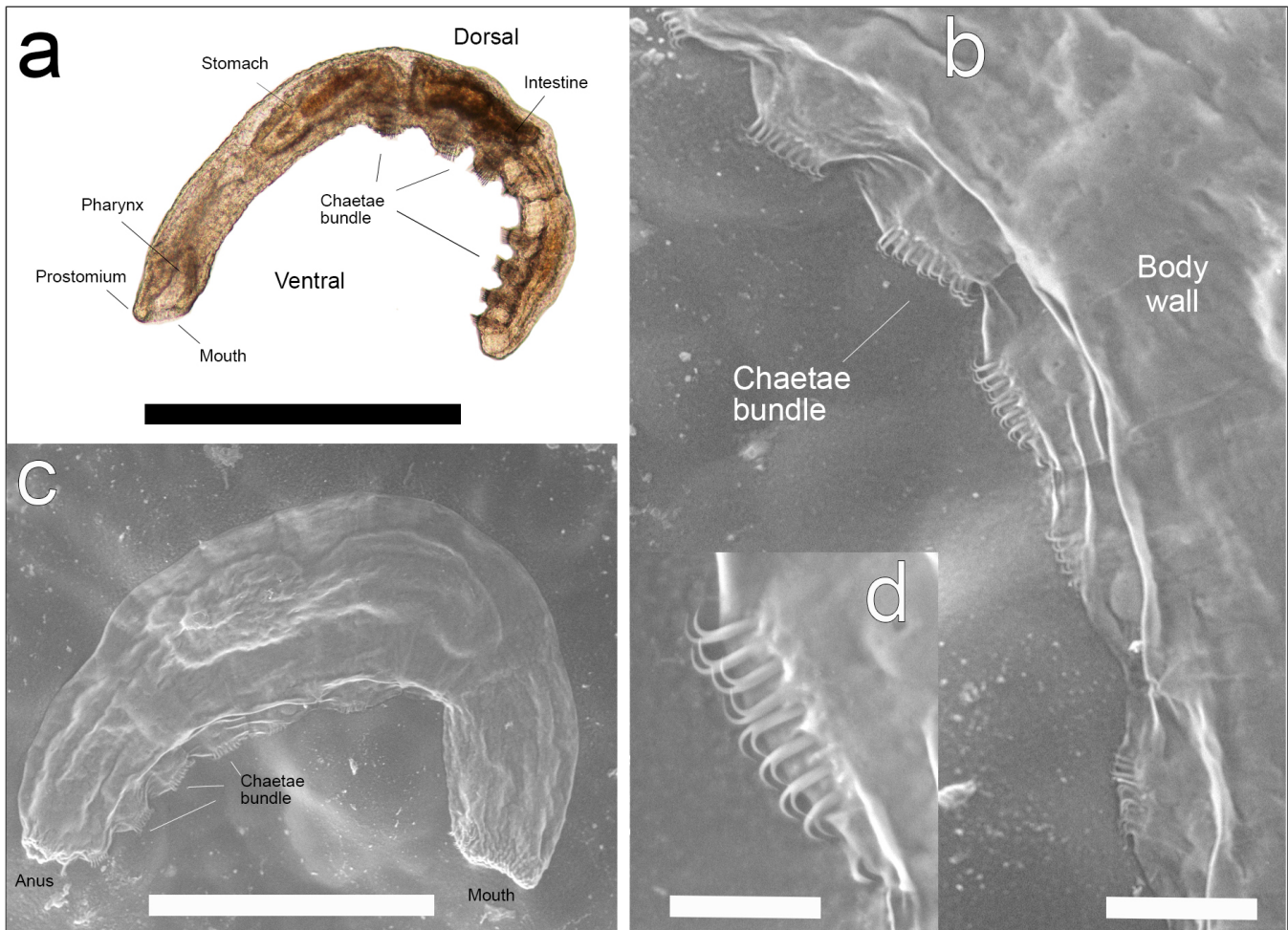


Figure 3. *Chaetogaster limnaei* retrieved from *Physa acuta* in the Bullileo reservoir, Maule Region, Chile. **a.** Living specimen seen with stereomicroscope. **b.** Ventral section of the body showing the chaetae bundles seen with SEM. **c.** Air dried specimen seen with SEM. **d.** Chaetae bundle seen at higher magnification. Scale bar **a**= 500 μ m; **b**= 50 μ m; **c**= 300 μ m; **d**= 20 μ m.

ydd, 1965, distinct from the nominotypical subspecies *Chaetogaster limnaei limnaei* Von Baer, 1927. The latter is known to inhabit the mantle cavity of snails, where it reduces parasitic trematode infection by feeding on their larvae, effectively acting as a commensal (Gruffydd 1965a,b, Khalil 1961, Michelson 1964, Rodgers *et al.* 2005; Zimmermann *et al.* 2011). On the other hand, *C. limnaei vaghini* was long considered an endoparasite restricted to the host's renal system, where it would feed on renal cells (Gruffydd, 1965a,b). However, Smythe *et al.* (2015) demonstrated that this separation between subspecies may not be justified.

The largest number of worms present in *P. acuta* from Bullileo reservoir was four, the same value reported by Ibrahim (2007), but much less than the 24 reported by Andrade and Campos (1968) in *Biomphalaria straminea*

(Dunker, 1848), the 70 mentioned by Gruffydd (1965a) in *Radix peregra* (Müller, 1774) and 300 in *Lymnaea stagnalis* (Linnaeus, 1758) (see Michelson 1964). The prevalence of worms in *P. acuta* reported in the present study (39.1%) is slightly higher than that previously cited for the Illapel River in northern Chile (27.3%) (Collado *et al.* 2019). In Iraq, Bashê (2023) reported a maximum infection prevalence of 9.4%.

It has been reported high population densities of *C. limnaei* in *P. acuta* in the Delaware River in the spring and summer, which declines during the winter (Gamble and Fried 1976). The population dynamics of *C. limnaei* on *P. acuta* has not been studied in Chile. Moreover, as *P. acuta* has a wide distribution in this country, further studies are required to evaluate the distribution of *C. limnaei* on this highly invasive freshwater snail.

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AUTHOR'S CONTRIBUTION

KPA collected the snails; GAC analyzed data and wrote the paper. Both authors agree with the content of the article.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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