

NOTA CIENTÍFICA

NEW RECORD OF THE INVASIVE CHanneled APPLE SNAIL *POMACEA CANALICULATA* (LAMARCK, 1829) IN CENTRAL CHILEDiego Almendras García dalmendrasg@gmail.com

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ABSTRACT

In mid-January 2019, numerous egg clutches and active adult individuals of *Pomacea canaliculata* were sighted in an artificial lagoon in Santiago, Chile. This freshwater snail is endemic to the Lower Paraná and La Plata basins, and has been introduced and become established in many parts of the world. This new population, the second to be recorded in Chile, is situated 190km to the south of the small coastal lagoon where the snail was first sighted in 2009. Voucher specimens have been deposited in the collection of the Museo Nacional de Historia Natural and Sala de Colecciones Biológicas Universidad Católica del Norte. This early report highlights the need for local eradication as soon as possible, in order to avoid potential invasion by one of the World's 100 Worst Invasive Alien Species.

Keywords: Biological invasions, non-native, apple snails, Santiago, Ampullariidae

RESUMEN

Nuevo registro del invasor *Pomacea canaliculata* (Lamarck, 1829) en Chile central. A mediados de enero de 2019, se avistaron numerosas nidadas de huevos e individuos adultos activos de *Pomacea canaliculata* en una laguna artificial en Santiago, Chile. Este caracol de agua dulce es endémico de las cuencas del Bajo Paraná y La Plata, y se ha introducido y se ha establecido en muchas partes del mundo. Esta nueva población, la segunda que se registra en Chile, está situada 190 km al sur de la pequeña laguna costera donde el caracol fue avistado por primera vez en 2009. Se han depositado ejemplares de comprobantes en la colección del Museo Nacional de Historia Natural y Sala de Colecciones Biológicas Universidad Católica del Norte. Este primer informe destaca la necesidad de la erradicación local lo antes posible, a fin de evitar una posible invasión de una de las 100 peores especies exóticas invasoras del mundo.

Palabras clave: Invasiones biológicas, no nativas, caracoles, Santiago, Ampullariidae.

INTRODUCTION

There are several species in the genus *Pomacea* Perry, 1810 that have, via anthropogenic means, been introduced and become established as pests in many parts of the world (Hayes *et al.* 2012; Yang *et al.* 2018). One example is the channeled apple snail *Pomacea canaliculata* (Lamarck, 1822) (Gastropoda: Ampullariidae), a freshwater snail native to southern South America, restricted to the Lower Paraná, Uruguay and La Plata Basins, although based on habitat similarity and watershed connections it is possible that it may also occur in the lower reaches of the Upper Paraná and parts of southern Brazil (Hayes *et al.* 2012). During the last three decades it has invaded Asia, Europe, North America, some Pacific Islands and non-native locations within South and Central Americas (San Martín *et al.* 2009; Tamburi and Martín 2011; Horgan *et al.* 2014; Cowie *et al.* 2017). Channeled apple snails have a voracious appetite, reproduce rapidly, are resistant to desiccation during dry periods, and act as vectors for zoonotic diseases, all of which have made them serious agricultural and environmental pests, whilst posing a potentially significant threat to human health through their role as an intermediate host for the nematode *Angiostrongylus cantonensis* (Chen, 1935), (Yang *et al.* 2018). In fact, this species is the only freshwater snail listed among the 100 of the World's Worst Invasive Alien Species (Lowe *et al.* 2000), although some of the impact may be attributable to *Pomacea insularum* (Tamburi and Martín 2011). In Chile, *Pomacea canaliculata* was detected for the

first time in Conchalí Lagoon (31°52'20.25"S; 71°29'51.93"W), a coastal wetland located 4 km north of the town of Los Vilos, Coquimbo region (Figure 1) (Jackson and Jackson 2009; Letelier *et al.* 2016). The only other record of *Pomacea* in Chile was made by Letelier *et al.* (2007) who detected *Pomacea bridgesii* (Reeve, 1856) in freshwater aquariums in Santiago, recognizing it as an exotic species in the country. For the effective management of invasive alien species, early detection and the ability to track their spread are critical. Here, based on external morphological characteristics, I report the presence of *Pomacea canaliculata* (Lamarck, 1822), in an artificial urban lagoon in Santiago, Chile.

MATERIALS AND METHODS

The snails were found on 23 January, 2019, at Laguna del Muelle, a small artificial lagoon (33°24'20.93"S; 70°36'9.13"W), within Bicentennial Park (Parque Bicentenario), a nature park located in Vitacura, Santiago Province, Metropolitan Region, Chile (Figure 1). Snails and egg clutches were photographed in situ and taken from the shore of the artificial lagoon.

Identification of external morphological characters was carried out using Hayes *et al.* (2012), and the identification of egg clutches following Kyle *et al.* (2013). External morphological characters and egg clutch shape match with Jackson and Jackson (2009) and Letelier *et al.* (2016), allowing this species to be established as *Pomacea analiculata* (Lamarck, 1822). Eggs were counted in situ, from available egg clutches. Snails and egg clutches were fixed using alcohol 75% and deposited in the Museo Nacional de Historia Natural (MNHNCL), Santiago (number MNHNCL 204840), and the Sala de Colecciones Biológicas, Universidad Católica del Norte (SCBUCN), Coquimbo, Chile (number SCBUCN-8102).

RESULTS

Snails present with a globular, thin and smooth shell, ranging ~35–60 mm in adult shell length, sometimes with reddish to dark-brown spiral color bands, variable in number and thickness; periostracum is yellow–brown to dark brown; shoulder is rounded; spire height is low; aperture is ovoid to kidney shaped; inside of pallial lip of shell unpigmented (Figure 2 A, B). Operculum is moderately thick and flexible. Egg clutches observed were bright reddish-pink to orange-pink, gelatinous, with a calcified shell. Within 6 egg clutches, egg numbers ranged from 63 to 259, and these were found attached to *Alisma plantago-aquatica*, *Cyperus eragrostis*, rocks, concrete and metal structures in the artificial lagoon (Figure 2 C, D). Descriptions of shell, operculum, eggs and egg clutch morphology of the specimens found in Bicentennial Park agree with those made by Thiengo *et al.* 1993, Jackson and Jackson 2009; Hayes *et al.* 2012, Kyle *et al.* 2013; and Letelier *et al.* 2016.

DISCUSSION AND CONCLUSION

External morphological characteristics allow the taxonomic identification of these snails to be confirmed as *Pomacea canaliculata*, due their large size and shape, rounded whorl shoulder, unpigmented inner pallial lip, presence of operculum, as well their oviposition, making them unique and not comparable to any native snail species in the country; even immature specimens can be identified by their deeply channeled sutures and rounded shoulders (Jackson and Jackson 2009; Kyle *et al.* 2013).

This species was formerly restricted to Laguna Conchalí, a coastal wetland in northern Chile (Jackson and Jackson 2009). It has been suggested that the snail was introduced to Laguna Conchalí by Argentinian tourists prior to 2007 (Báez *et al.* 2013). The presence of *Pomacea canaliculata* in an artificial lagoon

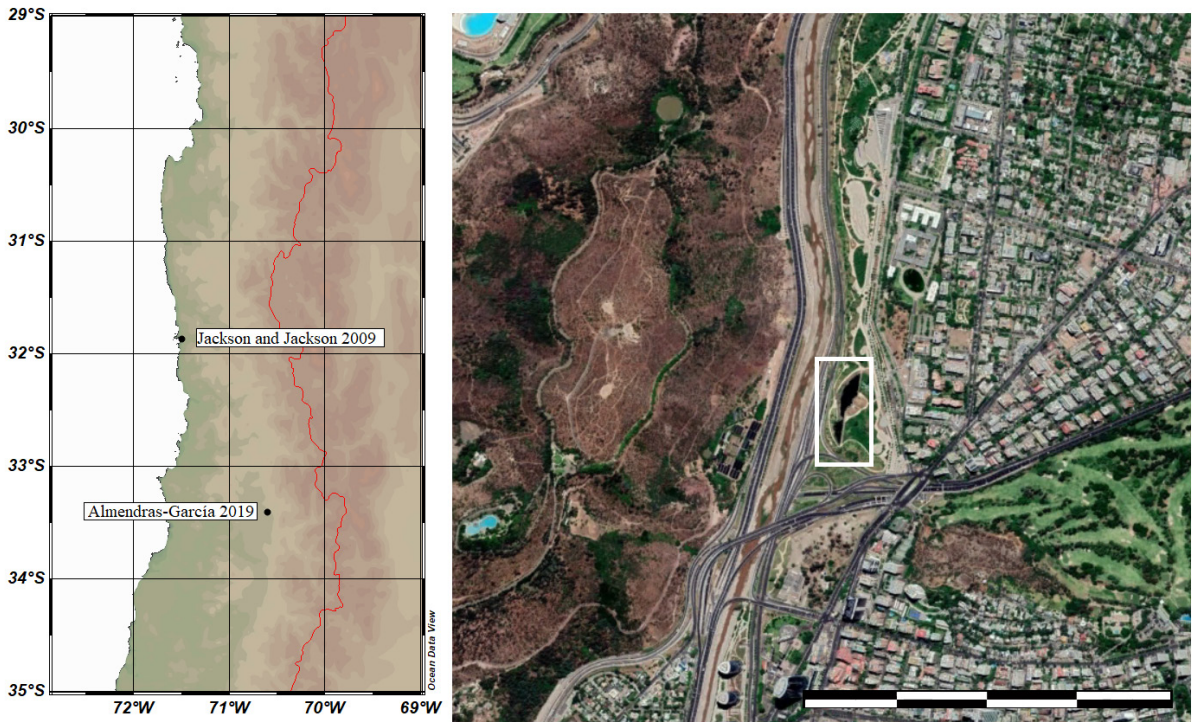


Figure 1. Map showing previous and new record of *Pomacea canaliculata* in Chile. In detail, area surveyed at Bicentennial Park: The black square indicates Laguna del Muelle, where channeled apple snails were found and collected. Scale bar represents 1000 m.

could be a consequence of optimum conditions for this species' development and survival. There are no data available on how long this species has existed in Laguna del Muelle. In conversations with gardeners of the Bicentennial Park, they told me about the first sightings of this snail by 2017, apparently introduced intentionally. COI analysis should be conducted to follow the trail of these snails, with humans as the most likely dispersal vector, as suggested by Letelier *et al.* (2016). Clarification of the invasive process from native to invaded areas will limit further invasion and expansion of the invasive apple snail. In Chile, the relationship of *Pomacea canaliculata* acting as vector for the nematode *Angiostrongylus cantonensis* is still unclear (Jackson and Jackson 2009; Letelier *et al.* 2016); however, health authorities must be alerted, in order to rule out the presence of the nematode.

Additionally, *Pomacea canaliculata* eggs contain perivitellin-2 (PcPV2), a potent defensive neurotoxin that damages the spinal cord of mice within 30 hours of ingestion (Heras *et al.* 2017).

Early detection and rapid response against invasive species is a critical component of any effective invasive species management program. Thus, detection is essential for effective control and eradication (Mehta *et al.* 2007). Consequently, early detection of non-native invasive species holds the best potential to avoid the considerable economic and ecological costs that often result from successful establishment (Kyle *et al.* 2013). Although snails were not counted, they seem to be abundant in the artificial lagoon, with a visibly high amount of egg clutches. The easy accessibility of snails and eggs in the artificial lagoon gives an opportunity for authorities, managers and researchers to achieve effective control of the apple snail, as this is a closed, shallow and relatively small artificial lagoon. Ducks are recommended for biological control

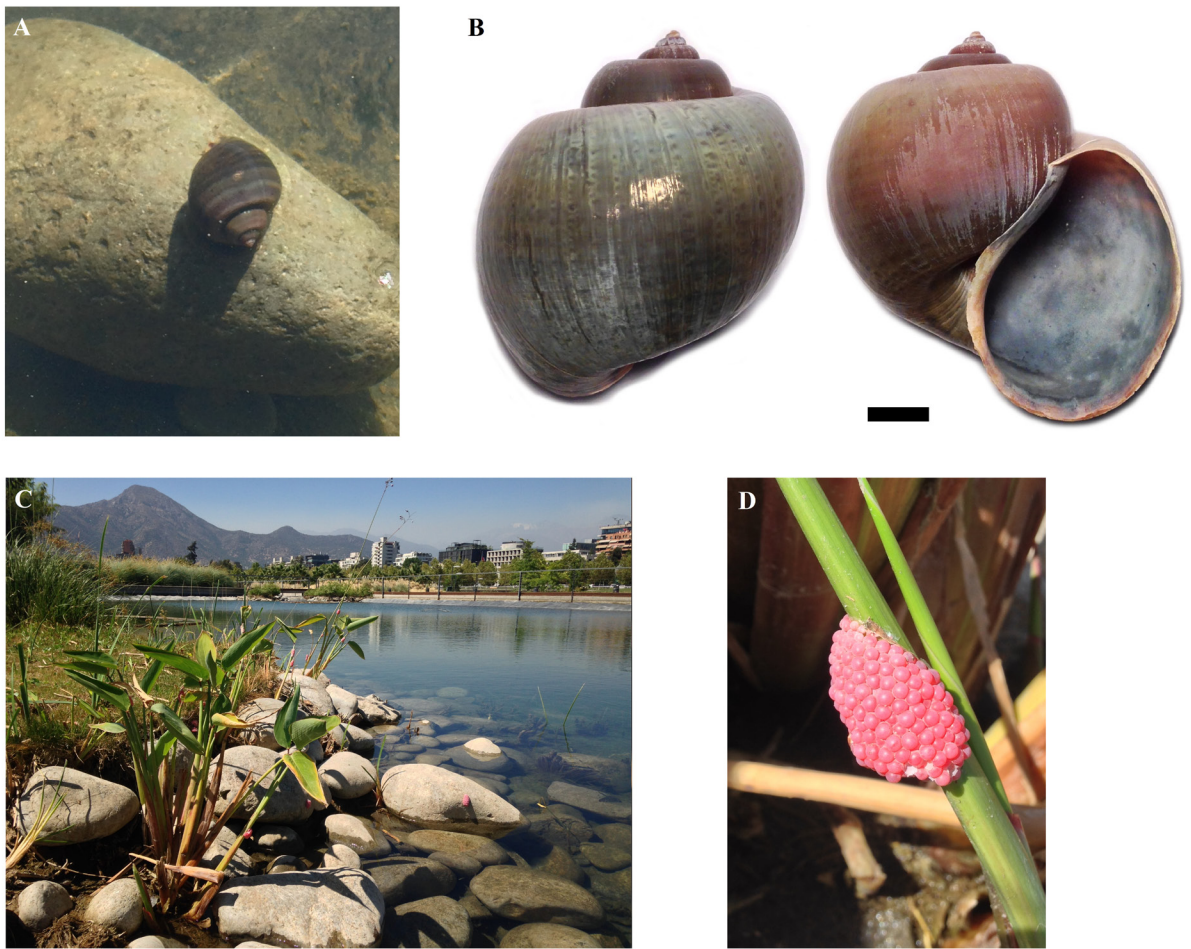


Figure 2. Mature channeled apple snails and egg clutches found in Laguna del Muelle at Parque Bicentenario. A) Living mature, B) dorsal and ventral/apertural view of a shell found in the shore of the artificial lagoon, C) egg clutches attached to rocks and *Alisma plantago-aquatica*, and D) detail of an egg clutch. Scale bar = 1 cm.

of snails in rice fields, with a high and consistent efficacy (Teo 2001). Molluscicides based on saponin have shown effectiveness against apple snails, suggesting an economical way to address this invasion (San Martín *et al.* 2009). An eradication plan must be addressed as soon as possible, coupled with effective monitoring of this and other artificial/urban lagoons and ponds in the city of Santiago, along with public awareness on invasive species and the problems they can cause.

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REFERENCES

- BÁEZ, P., S. LETELIER, G. ROJAS, A. REBOLLEDO, A. MARTÍNEZ and P. PAREDES. 2013. Patrimonio natural acuático y bioseguridad en los humedales costeros del semiárido de Chile: reflexiones para un estudio de caso, el caracol exótico *Pomacea canaliculata*. *Gestión Ambiental* 26: 51–63.
- COWIE, R.H., K.A. HAYES, E.E. STRONG and S.C. THIENGO. 2017. Non-native apple snails: systematics, distribution, invasion history and reasons for introduction. In Joshi, R., R.H. Cowie, and L.S. Sebastian (eds): *Biology and management of invasive apple snail* (pp. 3–32). Philippine Rice Research Institute (PhilRice), Maligaya, Science City of Muñoz, Nueva Ecija.
- HAYES, K.A., R.H. COWIE, S.C. THIENGO and E.E. STRONG. 2012. Comparing apples with apples: clarifying the identities of two highly invasive Neotropical Ampullariidae (Caenogastropoda). *Zoological Journal of the Linnean Society* 166(4): 723–753. DOI: 10.1111/j.1096-3642.2012.00867.x
- HERAS, H., M.S. DREON, S. ITUARTE, M.Y. PASQUIVICH and M.P. CADIerno. 2017. Apple snail perivitellins, multifunctional egg proteins. In Joshi, R., R.H. Cowie, and L.S. Sebastian (eds): *Biology and management of invasive apple snail* (pp. 99–117). Philippine Rice Research Institute (PhilRice), Maligaya, Science City of Muñoz, Nueva Ecija.
- HORGAN, F., M.I. FELIX, D.E. PORTALANZA, L. SÁNCHEZ, W.M. MOYA RIOS, S.E. FARAH, J.A. WITHER, C.I. ANDRADE and E.B. ESPIN. 2014. Responses by farmers to the apple snail invasion of Ecuador's rice fields and attitudes toward predatory snail kites. *Crop Protection* 62: 135–143. DOI: 10.1016/j.cropro.2014.04.019
- JACKSON, D. and D. JACKSON. 2009. Registro de *Pomacea canaliculata* (Lamarck, 1822) (Ampullariidae), molusco exótico para el norte de Chile. *Gayana* 73(1): 40–44. DOI: 10.4067/S0717-65382009000100006
- KYLE, C.H., A.L. PLANTZ, T. SHELTON and R.L. BURKS. 2013. Count your eggs before they invade: identifying and quantifying egg clutches of two invasive apple snail species (*Pomacea*). *PLoS ONE* 8(10): 1–11. DOI: 10.1371/journal.pone.0077736
- LETELIER, S., A.M. RAMOS and L.G. HUAQUÍN. 2007. Moluscos dulceacuícolas exóticos en Chile. *Revista Mexicana de Biodiversidad* 78: 9–13.
- LETELIER, S., A. REBOLLEDO, P. BÁEZ, A. FABRES, S. SOTO-ACUÑA, D. JACKSON, P. MANSILLA and G.A. COLLADO. 2016. The highly invasive freshwater apple snail *Pomacea canaliculata* (Gastropoda: Ampullariidae) in Northern Chile: morphological and molecular confirmation. *The Journal of Zoology Studies* 3(5): 119–128.
- LOWE, S., M. BROWNE, S. BOUDJELAS and M. DE POORTER. 2000. 100 of the world's worst invasive alien species: a selection from the global invasive species database. Auckland: The Invasive Species Specialists Group of the Species Survival Commission of the World Conservation Union.
- MEHTA, S.V., R.G. HAIGHT, F.R. HOMANS, S. POLASKY and R.C. VENETTE. 2007. Optimal detection and control strategies for invasive species management. *Ecological Economics* 61(2–3): 237–245. DOI: 10.1016/j.ecolecon.2006.10.024
- SAN MARTÍN, S.R., C. GELMI, J.V. DE OLIVEIRA, J.L. GALO and H. PRANTO. 2009. Use of a saponin based molluscicide to control *Pomacea canaliculata* snail in Southern Brazil. *Natural Product Communications* 4 (10): 1327–1330
- TAMBURI, N.E. and P.R. MARTÍN. 2011. Effects of food availability on reproductive output, offspring quality and reproductive efficiency in the apple snail *Pomacea canaliculata*. *Biological Invasions* 13(10): 2351–2360. DOI: 10.1007/s10530-011-0047-2
- TEO, S.S. 2001. Evaluation of different duck varieties for the control of the golden apple snail (*Pomacea canaliculata*) in transplanted and direct seeded rice. *Crop Protection* 20: 599–604. DOI: 10.1016/S0261-2194(01)00029-1
- THIENGO, S.C., C.E. BORDA and J.L. BARROS ARAÚJO. 1993. On *Pomacea canaliculata* (Lamarck, 1822) (Mollusca; Pilidae: Ampullariidae). *Memórias Do Instituto Oswaldo Cruz* 88(1): 67–71. DOI: 10.1590/S0074-02761993000100011
- YANG, Q.Q., S.W. LIU, C. HE y X.P. YU. 2018. Distribution and the origin of invasive apple snails, *Pomacea canaliculata* and *P. maculate* (Gastropoda: Ampullariidae) in China. *Scientific Reports* 8(1): 1–8. DOI: 10.1038/s41598-017-19000-7