



An annotated checklist of Planorbinae (Heterobranchia, Hygrophila, Planorbidae) from northwestern Argentina

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Abstract

The family Planorbidae comprises freshwater gastropods with planispiral, spiral and limpet-shaped shells. Subfamily Planorbinae *sensu stricto*, has a richness of almost 300 species, with some of the main genera being *Biomphalaria* Preston, 1910 and *Drepanotrema* Fischer & Crosse, 1880. Some *Biomphalaria* species are of concern to human health as they are intermediate hosts of blood flukes in Latin America. In Argentina, the family Planorbidae is represented by 15 species in four genera. In Northern Argentina (NOA region), records of the family are scarce, and most of them are a result of occasional collecting. We provide an updated checklist of Planorbinae in NOA resulting from fieldwork, material in malacological collections, and data in the literature. Nine species occur in the area: four species of *Biomphalaria* and five of *Drepanotrema*. Among *Biomphalaria* species, we recorded *Biomphalaria straminea* (Dunker, 1848), which is considered a natural host of the blood fluke *Schistosoma mansoni* Sambon, 1907, for first time in Salta province; the known geographic distribution of *B. straminea* is extended in the country.

Keywords

Basommatophora, freshwater snails, Mollusca, South America

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Introduction

The family Planorbidae Rafinesque, 1815 is one of the most diverse families of freshwater gastropods (Albrecht et al. 2007) and generally comprises forms with planispiral shells and spiral shells (*Plesiophysa* Fischer, 1883, *Acorbis* Odhner, 1937, *Bulinus* Müller, 1781, *Amerianna* Strand, 1928) and almost limpet-shaped species (*Patelloplanorbis* Hubendick, 1957 and Ancylinae) (Hubendick 1978; Albrecht et al. 2007; Cuezco 2009).

Planorbids live in a wide variety of habitats such as flooded areas, lagoons, streams, rivers, drainage channels, marshes, and ditches (Paraense 1975a, 1975b; Rumi 1991; Pointier 2008). Although they are usually found attached to aquatic vegetation or on the bottom substrate, some species such as *Acorbis petricola* Odhner, 1937 inhabit high-energy freshwater environments in a landscape dominated by subtropical forest (Vogler et al. 2019).

Planorbidae are cosmopolitan in distribution (Baker 1945; Albrecht et al. 2007; Cuezco 2009), although some genera such as *Bulinus* have a more restricted natural distribution (Hubendick 1948). In the Neotropical region, *Biomphalaria* and *Drepanotrema* Fischer & Crosse, 1880 are the most frequently cited genera in malacofaunal species lists (Tillier 1980; Quintana 1982; Rumi 1991; Martínez 2003; Ramírez et al. 2003; Scarabino 2004; Simone 2006), but other exotic genera are also present in the region. *Helisoma* Swainson, 1840 has been reported from Peru and Venezuela (Martínez 2003; Ramírez et al. 2003), and *Gyraulus* Charpentier, 1837, *Helisoma*, *Amerianna*, and *Indoplanorbis* Annandale & Prasad, 1920 have all been recorded in the Caribbean area (Pointier 2008).

According to the proposal of Albrecht et al. (2007), the family Planorbidae is divided into two subfamilies, Ancylinae and Planorbinae, and in the Planorbinae *sensu lato* there are about 40 genera and an estimated 200 (Meier-Brook 2002; Albrecht et al. 2007) to 350 (Hubendick 1955) species. In Argentina, Planorbinae are represented by 15 species in four genera (Rumi et al. 2006, 2008): *Acorbis*, *Antillorbis* Harry & Hubendick, 1964, *Biomphalaria*, and *Drepanotrema*. Current knowledge in Argentina of the systematics, morphology, and distribution of the subfamily is concentrated in the La Plata Basin, but in other regions, such as northern Argentina, it is scarce. Records of species in northern Argentina are the result of occasional collecting (Paraense 2005; Rumi et al. 2008), and for this reason, the aim of this study is to

provide a taxonomic update of the species of Planorbinae present in northern Argentina, with the inclusion of new records.

Study Area

Our study was carried out in the Northwest Region of Argentina (NOA) and included four provinces: Jujuy, Salta, Tucumán, and Catamarca. This region extends from 20°00'–30°05'S to 62°21'–69°25'W with an area of 333 km². The region is subtropical with well-defined wet and dry periods (Paolini et al. 2005). The geography of this region is strongly affected by the relief, which has an impact on the weather, vegetation, and hydrography (Sesma et al. 1998). The area includes heterogeneous aquatic ecosystems, still little-studied with respect to the mollusk fauna, like lakes, marshes, swamps, and small reservoirs (78 ha of average area; Cristóbal 2005), which are located mainly in the jungle piedmont of the Yungas ecoregion bordered on the east by dry lowland vegetation of the Chaco plains. Four main river basins are present in the study area: Bermejo, Juramento, Salí-Dulce and San Francisco (Paoli et al. 2011; Nieto et al. 2017) (Fig. 1).

The Juramento river basin covers part of the northwest of Salta, a small portion of southern Jujuy, and northeastern portions Catamarca and Tucumán. Its area is 32,885 km². The Juramento River is its main tributary and, together with the Salado River, forms a fluvial system of about 1,500 km long (Paoli et al. 2011).

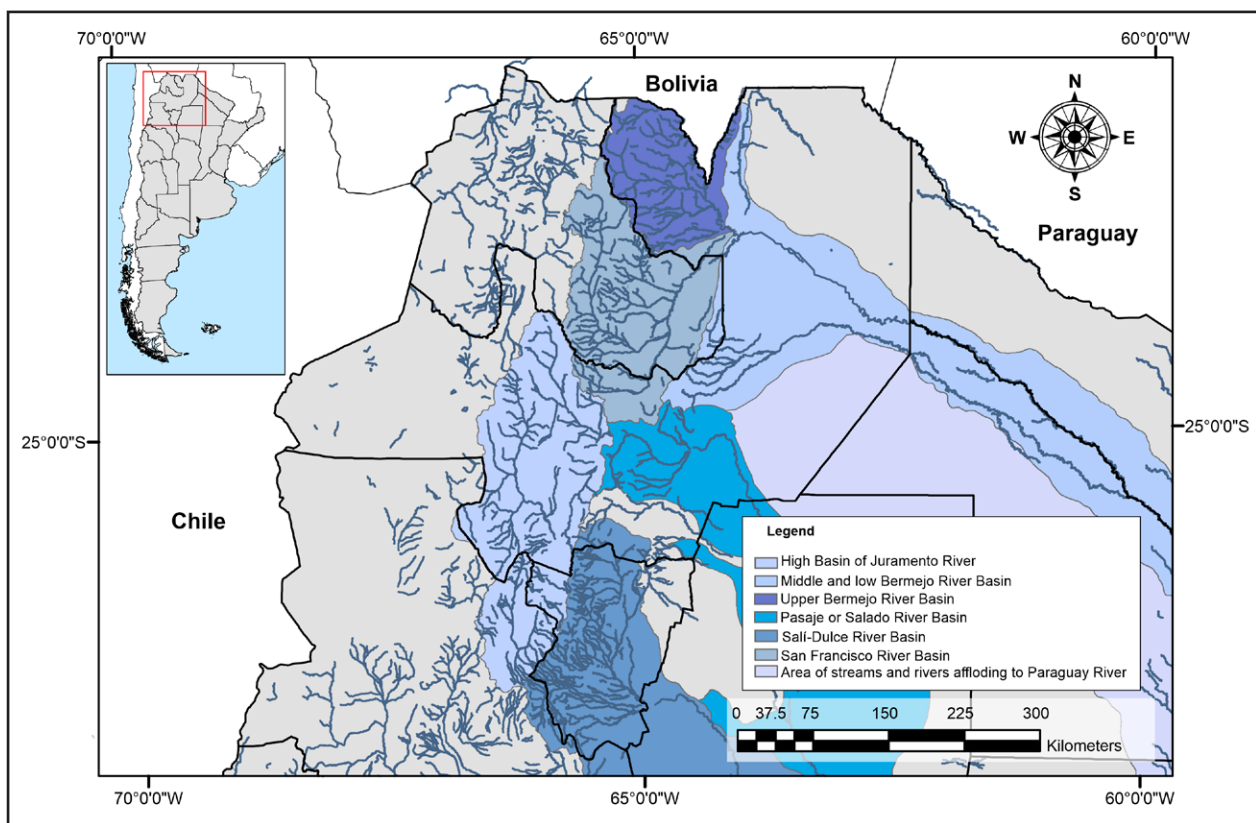


Figure 1. Study area showing the rivers and main basins.

The Bermejo river basin lies in Bolivia and Argentina. In Argentina, it extends into parts of Formosa, Chaco, Salta, and Jujuy provinces. The confluence of the Condado and Bermejo Chico rivers form the upper Bermejo River, which, when joining the Grande de Tarija River (Bolivia), constitutes the international border between Argentina and Bolivia. In Argentine territory, the Bermejo joins the San Francisco River, forming the lower or lower basin of the Bermejo (Paoli et al. 2011).

The Salí-Dulce River basin is mainly in the province of Tucumán but originates in Salta province as the Salí River. This river changes name in Tucumán province, where it diagonally crosses the province without receiving any tributary until it flows into the Mar Chiquita lagoon, in the province of Córdoba (Paoli et al. 2011).

The San Francisco river basin is also known as the Mojotoro-Lavayén-San Francisco basin, it includes the water courses that drain from the southern and western sectors of the Salta and Jujuy provinces. It has an area of 24,637 km² (Paoli et al. 2011).

Methods

Fieldwork was carried out in various localities of northern Argentina during spring to autumn of 2008 to 2012. Additionally, material housed in the main malacological collections of following institutions was examined: IFML (Instituto Fundación Miguel Lillo, Tucumán, Argentina), MACN-In (Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina), and MLP (Museo de La Plata, La Plata, Argentina). Literature from Scielo, Scopus, and Web of Science databases was consulted for additional data from some localities. For each species included in this checklist, information about of the type material is included whenever possible. The type locality is also given within quotation marks, as stated in original publications.

Material collected in our fieldwork was deposited in the Instituto de Biodiversidad Neotropical, Tucumán, Argentina under acronyms BD # and BDAD#. Living specimens were anesthetized and fixed following the methods of Paraense and Deslandes (1959), Paraense (1975b), and Barbosa (1995). To identify the species, shell morphology and reproductive systems were studied following Paraense (1961, 1975a, 1978, 2008) and Barbosa (1995).

A distribution map of the planorbid species in the study area was produced incorporating administrative area, watershed, and river layers and occurrence records (Table 1). Layers of administrative areas and water courses of Argentina were obtained from DIVA resource (<http://www.diva-gis.org/gdata>) and the basin layer was obtained from GeoINTA (<http://geointa.inta.gov.ar>). Localities without exact geographic coordinates in the original source were georeferenced using the GEOLocate web application (<http://www.museum.tulane.edu/geolocate/web/webgeoref.aspx>) and Google Earth.

Results

Nine species of Planorbinae—four species of *Biomphalaria* and five species of *Drepanotrema*—were recorded in the study area. Furthermore, our new data expand the known distribution of *Biomphalaria orbignyi* Paraense, 1975, *B. peregrina* (d’Orbigny, 1835), and *B. tenagophila* (d’Orbigny, 1835). *Biomphalaria straminea* was recorded for the first time in Salta province, extending its distribution from northeastern to northwestern Argentina. San Francisco River and Salí-Dulce basins were the areas with the highest number of records of *Biomphalaria* species (Table 1). *Biomphalaria tenagophila* and *B. peregrina* were the most widely distributed species in the study area. The Middle and Lower Bermejo river basin had the greatest number of records of *Drepanotrema* species.

Subclass Heterobranchia Gray, 1840

Planorbidae Rafinesque, 1815

Biomphalaria Preston, 1910

Biomphalaria Preston 1910: 526—Barbosa et al. 1961: 371; Paraense 1975a: 116; Rumi 1991: 16; Paraense 2005: 491; Simone 2006: 102; Paraense 2008: 287.

Biomphalaria orbignyi Paraense, 1975

Biomphalaria orbignyi Paraense 1975b: 211—Rumi 1991: 20; Spatz et al. 2000: 807; Paraense 2005: 491; Rumi et al. 2008: 82.

Type material. Not located.

Type locality. “city of Paraná, capital of province of Entre Ríos ...”, “... at Parque Urquiza ... in a swampy area at Bajada Grande” (Paraense 1975).

Material examined. ARGENTINA – **Tucumán** • Salí River; 25.V.1967; W. Weyrauch leg., IFML-MOLL 17018 (ex CWW 745) • same data, IFML-MOLL 17016 (ex CWW 2653) • Graneros, Route 333; 1 km from the Route 157; 27°37'50"S, 065°15'32"W; 17.XI.2000; M.G Cuezco leg., BD # 437 • Simoca, Route 157, Manuela Pedraza, 27°12'18"S, 065°21'28"W; M.G Cuezco leg., BD # 573 • Trancas, Los Bolleritos watering place; 26°42'46"S, 065°09'34"W; 31.III.2009; X.M.C. Ovando leg., BDAD # 71.

Identification. Shell planispiral, pale brown, with six whorls; major diameter 8.41–10.49 mm. Aperture rounded, slightly displaced to right side by projection of the right peristomal lip (Fig. 2A). Reproductive system (Fig. 2A): vagina cylindrical, with a well-developed vaginal pouch on ventral side. Prostate with digitiform, bi- and trifurcate diverticula. Diameter of vas deferens non-constant throughout. Penis complex, with penis sheath narrower than prepuce, similar in length; middle portion of penis sheath similar in diameter to the ascending portion of vas deferens.

Distribution. This species was previously recorded in Santa Fe, Córdoba (Paraense 1975; Rumi 1991; Castellanos and Landoni 1995), La Rioja, Entre Ríos (Rumi 1991; Castellanos and Landoni 1995; Paraense 2005), Mendoza, Buenos Aires (Paraense 1975), Formosa

Table 1. Localities of occurrences of Planorbinae species in the NOA region by localities, provinces, and watershed.

Species	Catalogue no./reference	Province	Locality	Watershed
<i>Biomphalaria orbigny</i>	BD 437	Tucumán	Route 333, a 1 km from Route 157	Sali-Dulce River
	BD 57	Tucumán	Manuela Pedraza	Sali-Dulce River
	BDAD 71	Tucumán	Sali River	Sali-Dulce River
	BDAD 98	Tucumán	On the way to Pozo del Pescado	Sali-Dulce River
	BDAD 199	Tucumán	Graneros	Sali-Dulce River
	Paraense 2005	Jujuy	El Rodeo Lagoon	San Francisco River
	Paraense 2005	Salta	Embarcación	Middle and Lower Bermejo River
	Paraense 2005	Salta	Los Blancos	Paraguay River
<i>Biomphalaria peregrina</i>	BD 54	Tucumán	Pond	Sali-Dulce River
	BDAD 20	Tucumán	Salí River, Los Boyeritos	Sali-Dulce River
	BDAD 22	Tucumán	Salí River	Sali-Dulce River
	BDAD 28	Tucumán	Salí River	Sali-Dulce River
	BDAD 75	Tucumán	10 km to Trancas	Sali-Dulce River
	BDAD 91	Tucumán	Small pond	Sali-Dulce River
	MLP 7793	Salta	Lavallén River	San Francisco River
	MLP 12877-7018/2-7018/1	Jujuy	Abra Pampa River	La Puna Basins
	MLP 12768	Jujuy	El Rodeo River	San Francisco river
	Paraense, 2005	Jujuy	Comedero Lagoon	San Francisco river
	IFML-MOLL 17017	Jujuy	La Ciénaga, San Pedro	San Francisco River
	IFML-MOLL 17024	Tucumán	Escaba Dam	Sali-Dulce River
	IFML-MOLL 997	Tucumán	Comuna 7 de Abril	Rosario River
	MLP 7656	Jujuy	San Antonio de los Cobres	La Puna Basins
	IFML-MOLL 613	Tucumán	9 de Julio Park	Sali-Dulce River
	IFML-MOLL 331	Tucumán	Mista stream	Sali-Dulce River
<i>Biomphalaria tenagophila</i>	BD 427	Salta	El Tala	Sali-Dulce River
	DB 64	Jujuy	Zapla River passing Palpalá	San Francisco River
	BDAD 12	Jujuy	Route 56 to San Pedro de Jujuy	San Francisco River
	BDAD 30	Tucumán	Granja modelo	Sali-Dulce River
	BDAD 37	Salta	On the way to El Rey National Park	Salado River
	BDAD 40	Salta	El Rey National Park	Middle and Lower Bermejo River
	MLP 12890		Los Alisos Dam	San Francisco River
	Paraense 1995 2002	Salta	Los Avalos	San Francisco River
	Davies et al. 2015	Salta	Campo Alegre reservoir	La Puna Basins
	Davies et al. 2016	Salta	Puerta Díaz reservoir	Juramento River High Basin
	FML-MOLL 17023 (ex CWW 2652), IFML-MOLL 10602, 17027, 17028	Tucumán	fountain of Instituto Miguel Lillo	Sali-Dulce River
	IFML-MOLL 131	Tucumán	San Francisco stream	Sali-Dulce River
	Paraense 1997	Tucumán	Leocadio Paz	Sali-Dulce River
	MLP 12881	Jujuy	Los Alisos Reservoir	San Francisco River
	BDAD 204	Tucumán	El Tejar stream	Sali-Dulce River
	BDAD 114	Jujuy	Zapla River	San Francisco River
	BDAD 111	Jujuy	Zapla River	San Francisco River
	BDAD 45	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 53	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 56	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 60	Salta	On the way to El Rey National Park	Salado River
	BDAD 64	Salta	National Park	Middle and Lower Bermejo River
	BDAD 85	Tucumán	Crossing between Route R9 and Trancas city	Sali-Dulce River
	BDAD 240	Tucumán	Stream in Trancas city	Sali-Dulce River
	BDAD 95	Tucumán	Pozo del Pescado	Sali-Dulce River
	IFML-MOLL 148	Tucumán	El duraznito	Sali-Dulce River
	BDAD 137	Tucumán	El Cadillal	Sali-Dulce River
	MLP 5326	Tucumán	Singuil River	
	MLP 12899-12900	Jujuy	Volcán, Route 9	San Francisco River
	MLP 11765	Salta	Arias River	San Francisco River
	MLP 11840	Jujuy	Zapla	San Francisco River
	BDAD 213, IFML-MOLL 391, 14196, IFML-MOLL 17019	Tucumán	Escaba Reservoir	Sali-Dulce River
<i>Biomphalaria straminea</i>	Paraense 1997	Jujuy	San Salvador de Jujuy	San Francisco River
	BDAD 121	Salta	Pescado River	Upper Bermejo River
	BDAD 140	Salta	Pescado River	Upper Bermejo River
<i>Drepanotrema cimex</i>	BDAD 43	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 48	Salta	El Rey National Park	Middle and Lower Bermejo River

Species	Catalogue no./reference	Province	Locality	Watershed
<i>Drepanotrema depressissimum</i>	BDAD 38	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 47	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 63	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 84	Tucumán	Rio Nio	Rosario River
	BDAD 99	Salta	Coming back to Bananal	San Francisco River
	MLP12898	Jujuy	Route 156, San Francisco River	
	BDAD 20	Tucumán	Potrero de Las Tablas	Sali-Dulce River
	Paraense, 2005	Jujuy	San Salvador	San Francisco River
	IFML-MOLL 17020	Tucumán	Alto de Medina	Sali-Dulce River
	Paraense, 2005	Salta	Los Blancos	Paraguay River
<i>Drepanotrema kermatooides</i>	BD 56	Tucumán	Manuela Pedraza	Sali-Dulce River
	BDAD 31	Tucumán	La Cruz stream	Sali-Dulce River
	BDAD 42	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 52	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 76	Salta	El Rey National Park	Middle and Lower Bermejo River
	Paraense 2005	Tucumán	El Cadillal	Sali-Dulce River
	BDAD 81	Tucumán	Crossing Route 9 and Tancas	Sali-Dulce River
	BDAD 143	Salta	Pescado River	Upper Bermejo River
<i>Drepanotrema lucidum</i>	BDAD 57	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 44	Salta	El Rey National Park	Middle and Lower Bermejo River
	BDAD 59	Salta	El Rey National Park	Middle and Lower Bermejo River
	Paraense 2005	Salta	pond in Los Blancos	Paraguay river
<i>Drepanotrema nordestense</i>	BDAD 252	Jujuy	Reyes River	San Francisco River
	BDAD 261	Tucumán	Pozo del Pescado	Sali-Dulce River

(Paraense 1975b; Castellanos and Landoni 1995), and Corrientes (Rumi 1991). From the NOA region, Paraense (1975) had recorded localities mainly in northern Salta province. Our new records increase the known distribution of this species in the study area, mainly in the province of Tucumán (Fig. 3).

Biomphalaria peregrina (d'Orbigny, 1835)

Planorbis peregrinus d'Orbigny 1835: 26.

Tropicorbis peregrinus—Hylton Scott 1957: 1.

Taphius peregrinus—Paraense 1958: 152; Paraense and Deslandes 1958a: 152.

Biomphalaria peregrina—Paraense 1966: 269; Paraense 1975a:117; Rumi 1991: 21; Paraense 2005: 491; Simone 2006: 108.

Type material. Syntypes (NHMUK 1854.12.4.267.273) (Fig. 5A). 15 specimens.

Type locality. “Patagonia, Montevideo (república Uruguayensi orientali); Pampas; provincia Corrientes (república Argentina); provincia Rio-Grande (república Boliviana) et provincia Guayaquilensi (república Colombiana)” (d'Orbigny 1835).

As d'Orbigny did not specify a type locality, Rumi (1991) considered Neuquén province, Argentina as type locality, but this was not done according to the International Code of Zoological Nomenclature.

Material examined. ARGENTINA – **Salta** • Lavallén River; M. Birabén leg., MLP 7793 • Anta; El Rey National Park; A. Brown & L. Malmierca leg., MLP 4611 • Orán; 8.XII.1950; M. Birabén leg., MLP 7857 – **Jujuy** • Abra Pampa River; 18.V.2000; M. Tassara leg., MLP 12877 • El Rodeo Lagoon, Yala Provincial Park; 20.X.1998; M. Tassara leg., MLP 12768 • Route 9, Volcán; 28.IX.1999; M. Tassara leg., MLP 12900 • La Ciénaga, San Pedro, IFML-MOLL 17017 – **Tucumán** • Tucumán

city (in Rumi 1991) • Alberdi, Escaba dam; W. Weyrauch leg., IFML-MOLL 17024 (ex CWW 3139) • Buruyacú, 7 de abril; 400 m alt.; 16.VI.1965; W. Weyrauch leg., IFML-MOLL 997 • Los Bolleros watering place; 26°42'46"S, 065°09'34"W; 482 m alt.; 02.XII.2008; X.M.C. Ovando leg., BDAD # 20 • downstream Salí River; 26°44'09"S, 065°09'25"W; 476 m alt.; 02.XII.2008; X.M.C. Ovando leg., BDAD # 22 • same data above; 26°42'46"S, 065°9'34"W; 482 m alt.; 23.II.2009; X.M.C. Ovando leg., BDAD # 28 • Capital, 9 de Julio Park; 430 m alt.; 11.II.1962; W. Weyrauch leg., IFML-MOLL 613 • Trancas, Route 9, Salí River; M.G. Cuezco leg., BDAD # 17 • same data, IFML-MOLL 17026 (ex CWW 745) • same locality, IFML-MOLL 516 • under the bridge of Salí River; 26°11'22.0"S, 065°17'01.8"W; 915m alt.; 12.III.2009; X.M.C. Ovando leg., BDAD # 75 • El Boyero; 26°14'02.5"S, 065°15'15.7"W; 747 m alt.; 26.V.2009; P. Powell & X.M.C. Ovando leg., BDAD # 91 • on the way to Pozo del Pescado; 26°13'09.3"S, 065°16'33.6"W; 774 m alt.; 26.V.2009; P. Powell & X.M.C. Ovando leg., BDAD # 98 • Leales, Mista stream, IFML-MOLL 331.

Identification. Shell planispiral shell, 13–19 mm wide, light to dark brown. Whorls five; last whorl larger in diameter. Aperture rounded, reflected to the left side. Peristome with smooth, sharp edge, with right and left peristomal lips almost in the same plane (Fig. 2B). Reproductive system (Fig. 4B): ventral wall of the vagina with a small, cylindrical vaginal pouch. Prostate with thin diverticula, with three or four branches. Vas deferens long and thin; with diameter of the ascending portion slightly greater than descending portion. Penis complex, with penis sheath narrow in relation to prepuce, 1½× longer than prepuce; proximal portion of penis sheath

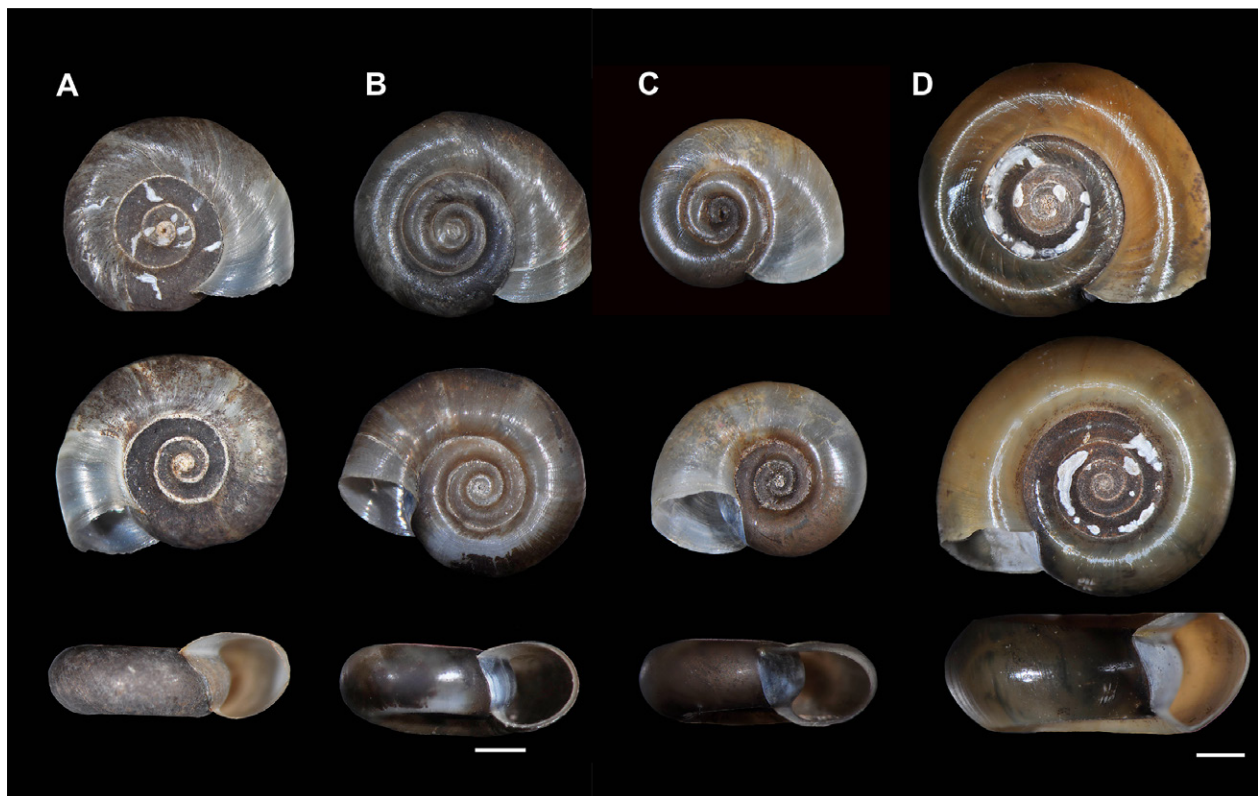


Figure 2. Shells of *Biomphalaria* species reported in northwestern Argentina (in right, left and side views, respectively). **A.** *Biomphalaria orbigny*. **B.** *Biomphalaria peregrina*. **C.** *Biomphalaria straminea*. **D.** *Biomphalaria tenagophila*. Scale bars: A–C = 3 mm; D = 2 mm.

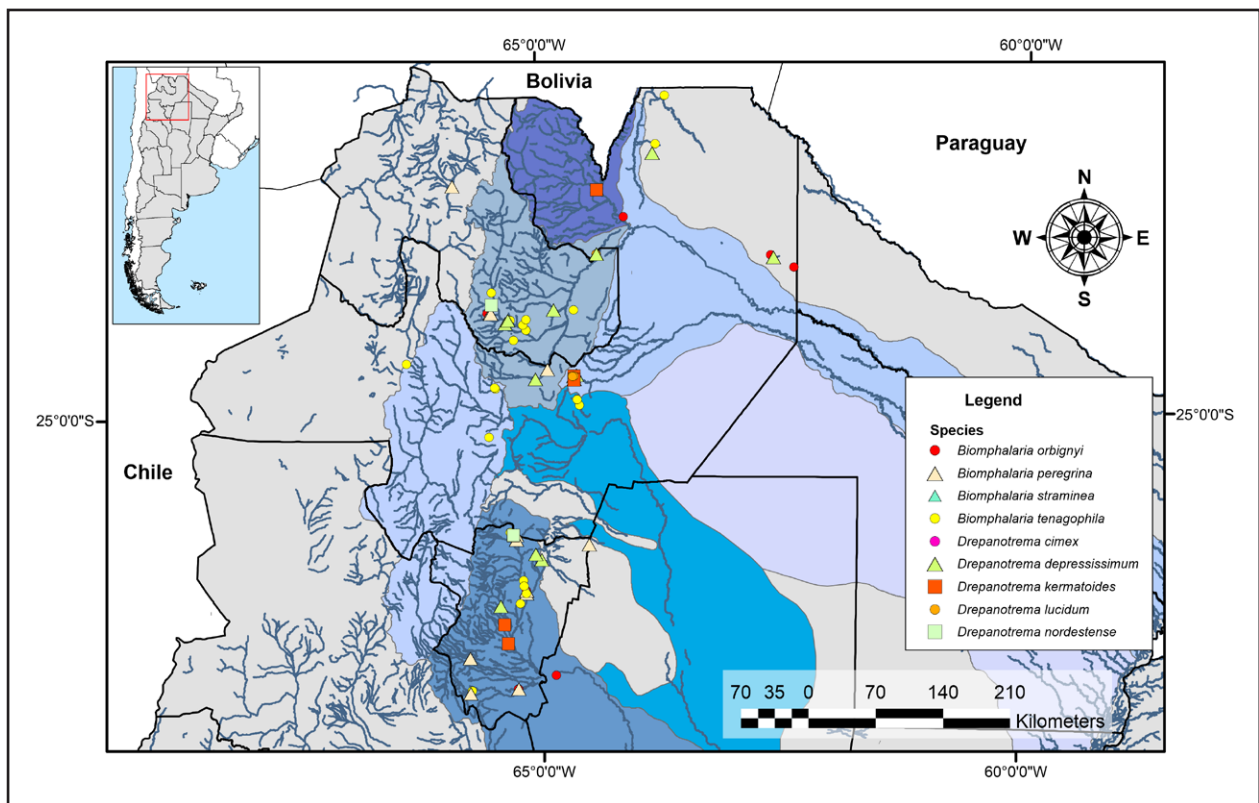


Figure 3. Distribution of Planorbiinae species in the study area.

similar in diameter to the distal portion of vas deferens, increasing its diameter in its distal portion.

Distribution. According to Paraense (2005) and (Rumi 1991), this species also occurs in the provinces of Corrientes, Misiones, Entre Ríos, Santa Fe, Buenos Aires, Rio Negro, Mendoza, and Neuquén. Castellanos and Landoni (1995) considered this species to be widely distributed in Argentina. Our new records from Tucumán and Salta expand the geographical distribution of this species to the NOA region (Fig. 3).

Biomphalaria straminea (Dunker, 1848)

Planorbis stramineus Dunker 1848: 42.

Taphius pfeifferi—Paraense and Deslandes 1957: 1.

Australorbis stramineus—Paraense 1963: 1.

Biomphalaria straminea—Paraense, 1975a: 105; Rumi 1991: 23; Paraense 2005: 492; Simone 2006: 109; Paraense 2008: 299; Rumi et al. 2008: 83; Thompson 2011: 71.

Type material. Syntypes (NHMUK 1969155) (Fig. 4B) 3 specimens.

Type locality. “Patria America Australis (H. Cuming)” (Dunker 1848). Martens (1873) restricted the type locality to Venezuela (Lagunilla and Caracas) and also reported this species from Ceará state, Brazil.

Material examined. ARGENTINA – **Salta** • Pescado River, small stream parallel to the river; 22°57'28.5"S, 064°23'6.7"W; 350 m alt.; X.M.C. Ovando leg., BDAD # 142.

Identification. Whorls five; body whorl subangular on the left side. Aperture oval, slightly displaced to the left (Fig. 2C). Reproductive system (Fig. 4C): dorsal wall of the vagina with transverse folds or undulations, without vaginal pouch. Prostate formed by short, thin diverticula, sometimes branching. Penis complex, with narrow penis sheath, 1½× longer than prepuce; proximal portion of the sheath similar in diameter to the distal portion of the vas deferens.

Distribution. In Argentina, records of *B. straminea* are concentrated in the Northeast: Corrientes (Paraense 1997, 2005), Chaco (Paraense 1997), and Misiones (Rumi et al. 2008). This species is also known from Buenos Aires and Córdoba (Rumi 1991; Castellanos and Landoni 1995; Paraense 2005), and Paraense (1997) recorded this species from Jujuy (Paraense 1997). Our new record in Salta province extends the known distribution of this species.

Biomphalaria tenagophila (d'Orbigny, 1835)

Planorbis tenagophilus d'Orbigny 1835: 26.

Taphius tenagophilus—Paraense and Deslandes 1959: 456.

Australorbis tenagophilus—Paraense 1961: 343.

Biomphalaria tenagophila—Paraense 1975a: 117; Olazarri 1981: 321; Bonetto et al. 1982: 2; Rumi 1991: 24; Simone 2006: 110; Rumi et al. 2008: 83.

Type material. Syntypes (NHMUK 1854.12.4.264-6) (Fig. 5C). 18 specimens.

Type locality. “provincia Corrientes (republica Argentina); provinciis Santa-Cruz [de la Sierra] et Chiquitos (republica Boliviana)” (d'Orbigny 1835). Later, d'Orbigny (1837: 347) expanded the type locality to “las Ensenadas,

provincia de Corrientes (république Argentine) ...”.

Material examined. ARGENTINA – **Jujuy** • Zapla River; M. Tassara leg., MLP 7010 • same locality; M. Tassara leg., MLP 12879 • Los Alisos Dam; 23.IX.1999; M. Tassara leg., MLP 12890 • same data above, MLP 12881 • Route 56, on the way to San Pedro de Jujuy; 24°16'03"S, 065°07'09"W; 965 m alt.; 22.III.1999; M.G. Cuezco leg., BDAD #12 • Zapla River upstream; 24°13'14.1"S, 065°09'04.7"W; 1105 m alt.; 08.V.2009; X.M.C. Ovando leg., BDAD # 111 • stream flowing into the Zapla River; 24°16'03"S, 065°07'10"W; 1940 m alt.; 31.V.2000; M.G. Cuezco leg., BD # 64 • Los Avalos (in Paraense 1995, 2002) – **Salta** • Pocitos; A. Prossen leg., MLP 7701 • Anta, El Rey National Park, on the way to Santa Elena; 10.VII.1979; D. Rumiz & A. Brown leg., MLP 11761 • Arias River, close to Salta city; 15.X.1997; M. Tassara leg., MLP 11765 • El Rey National Park, Pozo Verde; 13.XI.1982, MLP 11806 • Salta city; 10.VII.1944; R. Golbach leg., IFML-MOLL 886 • river on the road to El Rey National Park, Finca Vieja; 24°58'35.3"S, 064°34'48"W; 788 m alt.; 16.III.2009; E. Pero & X.M.C. Ovando leg., BDAD # 37 • same locality, 700 m to from the entry to the park; M.G. Cuezco leg., BDAD # 15 • same locality, lagoon on the road to Los Lobitos waterfall; 24°42'13.7"S, 064°37'58.8"W; 928 m alt.; 17.III.2009; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD # 40 • same locality, lagoon on the way to Aguas negras; 24°42'28.7"S, 064°38'20.6"W; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD # 45 • same locality, Los Patitos lagoon; on the way to Popayán; 24°43'59.2"S, 064°38'13.2"W; 886 m alt.; 18.III.2009; E. Pero, M.G. Cuezco, C. Nieto & X.M.C. Ovando leg., BDAD # 53 • stream on the way out to El Rey National Park; 24°55'24.4"S, 064°36'19.4"W; 864 m alt.; 20.III.2009; M.G. Cuezco & X.M.C. Ovando leg., BDAD # 60 • Urundel, on the road to San Lorenzo River; 23°33'43"S, 064°23'33"W; 316 m alt.; 11.V.2009; X.M.C. Ovando leg., BDAD # 107 – **Tucumán** • Burruyacu, El duraznito; 06.V.1947; W. Weyrauch leg., IFML-MOLL 148 • on the road to Timbó Nuevo, Salí River; 01.XI.1999; C. Ituarte leg., BDAD # 3 • Juan Bautista Alberdi, Escaba dam; 06.I.1956; M. Manfrini leg., IFML-MOLL 391 • same data above IFML-MOLL 14196 • same data above, IFML-MOLL 17019 (ex CWW 3137) • Capital, fountain of the Miguel Lillo Institute, IFML-MOLL 17023 (ex CWW 2652) • same data above, IFML-MOLL 10602 • same data above, IFML-MOLL 17027 • same data above IFML-MOLL 17028 • Trancas, San Francisco stream, IFML-MOLL 131 • after Pozo de San Francisco; 26°11'23"S, 065°16'58"W; 740 m alt.; M.G. Cuezco leg., BD# 427 • crossing between Route 9 and entrance to Trancas city; 26°11'28.8"S, 065°17'01.8"W; 915 m alt.; 12.III.2009; M.G. Cuezco & X.M.C. Ovando leg., BDAD # 85 • Pozo del Pescado, 26°11'27.9"S, 065°17'19.7"W; 788 m alt.; 26.V.2009; P. Powell & X.M.C. Ovando leg., BDAD # 95 • Leales, El Tejar stream, on the side of the route 157; 27°11'45.8"S, 065°21'32.7"W; 283 m alt.; M. Mitrovich & X.M.C. Ovando leg., BDAD # 204 • Tañi

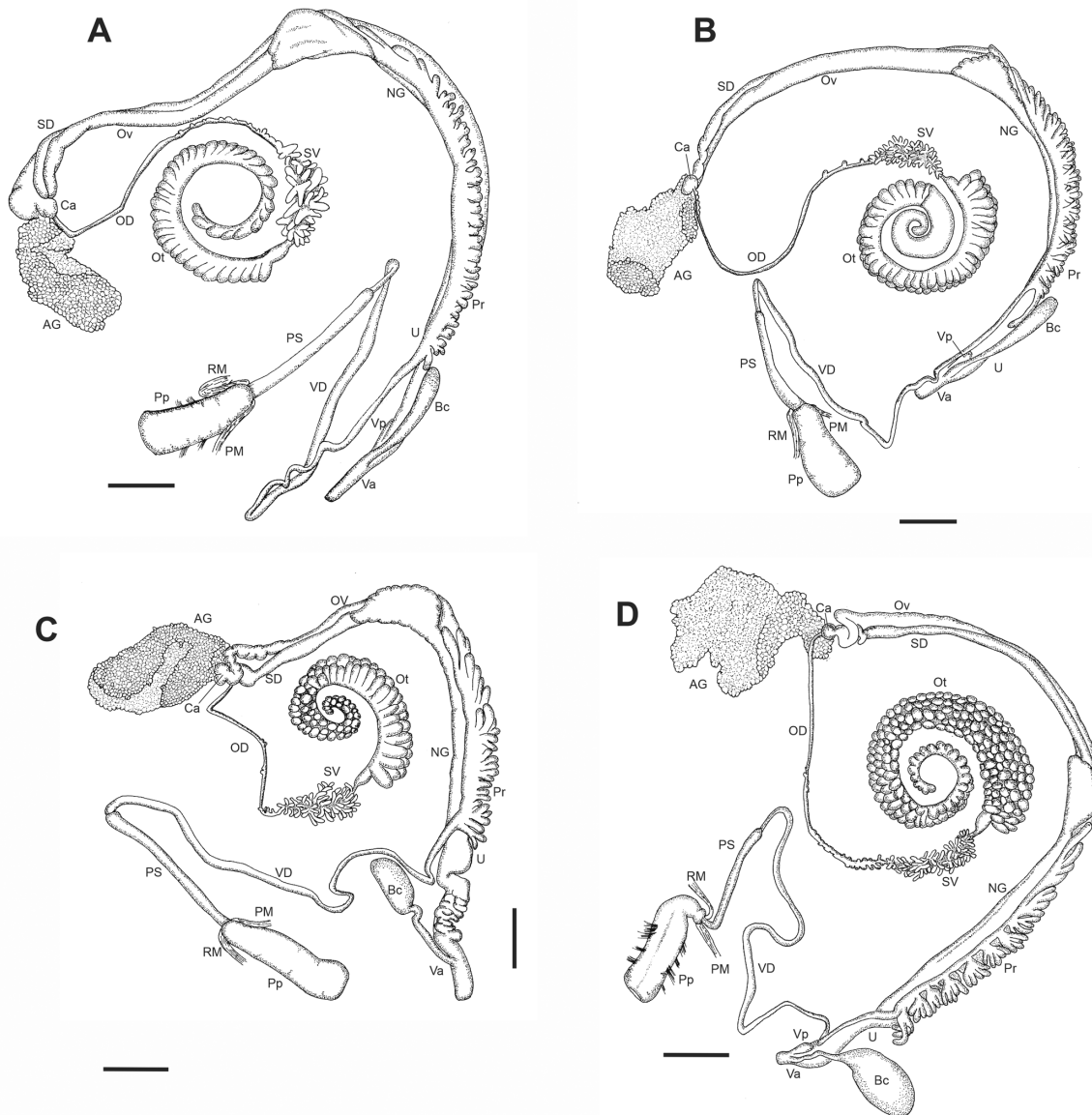


Figure 4. Reproductive system of *Biomphalaria* species. **A.** *Biomphalaria orbigny*. **B.** *Biomphalaria peregrina*. **C.** *Biomphalaria straminea*. **D.** *Biomphalaria tenagophila*. Abbreviations: AG = albumen gland, Bc = bursa copulatrix, Ca = carrefour, NG = nidamental gland, OD = ovisperm duct, Ov = oviduct, Ot = ovotestis, Pp = prepuce, PM = protractor muscle, PS = penis sac, RM = retractor muscle, SD = sperm duct, SV = seminal vesicle, Va = vagina, VP = vaginal pouch, VD = vas deferens. Scale bars = 1mm.

Viejo, El Cadillal; 26°36'57.8"S, 065°11'15.0"W; 547 m alt.; 12.III.2009; M.G. Cuezco & X.M.C. Ovando leg., BDAD # 137.

Identification. Shell planispiral, with seven to eight whorls, and carena well marked on basal side. Aperture deltoid, transverse, wider than long (Fig. 2 D). Reproductive system: hermaphroditic gland with cylindrical, small, short, and numerous diverticula. Vaginal pouch present, short, thin, on the ventral side of vagina. Prostate formed by long, thin, branched, arborescent diverticula. Penis complex, with thin penis sheath $\frac{1}{2}$ to $1\frac{1}{2}$ of prepuce (Fig. 4 D).

Distribution. This species is widely distributed in Argentina with numerous records from Buenos Aires (Rumi et al. 1997; Simões et al. 2013), Santa Fe, Entre

Ríos, Corrientes, Misiones, Formosa, Chaco, and Córdoba (Rumi 1991; Castellanos and Landoni 1995; Paraense 1997, 2005; Rumi et al. 2008). Castellanos and Landoni (1995) proposed that the distribution of *B. tenagophila* reaches northern Patagonia. Our new records from Salta, Jujuy, and Tucumán increase the known distribution of this species in the NOA.

***Drepanotrema* Crosse & Fischer, 1880**

Drepanotrema Crosse and Fischer 1880: 75—Baker 1945: 1; Paraense and Deslandes 1957: 339; Paraense 1958: 65; Paraense 1975a: 107; Rumi 1991: 26; Rumi et al. 2007: 559; Simone 2006: 102; Rumi et al. 2008: 83; Thompson 2011: 66.

Drepanostrema—Kennard and Woodward 1926: 69 [error for *Drepanotrema* Crosse & Fischer, 1880].

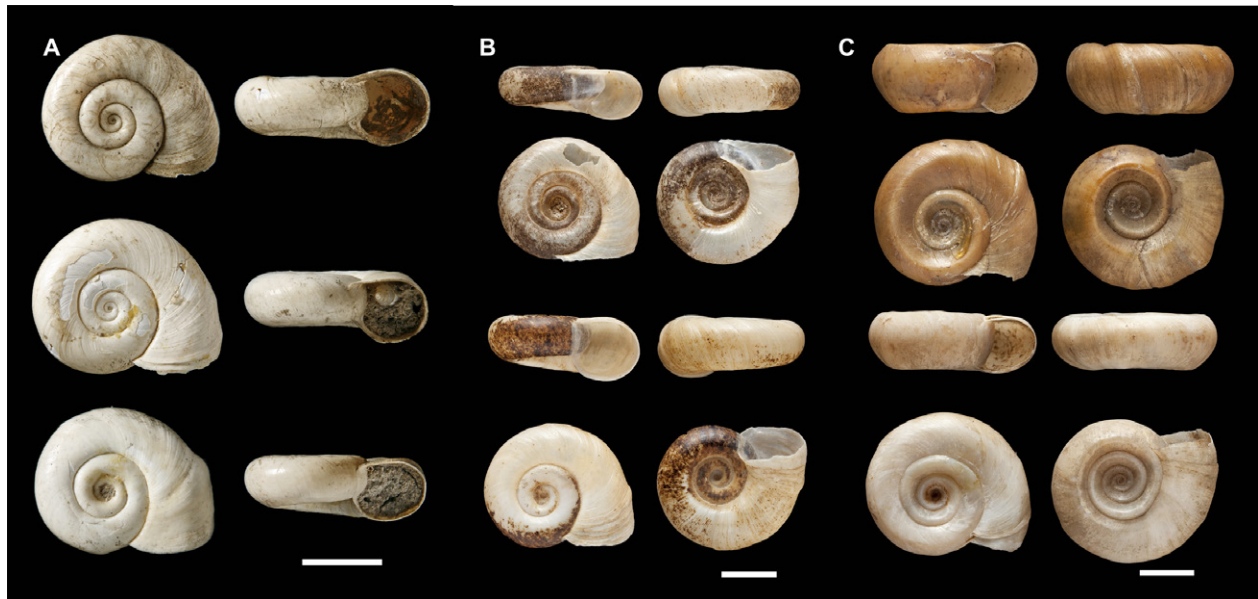


Figure 5. Syntypes of *Biomphalaria* species (in right, left and side views, respectively). **A.** *Biomphalaria peregrina* (NHMUK 1854.12.4.267.273). **B.** *Biomphalaria straminea* (NHMUK 1969155). **C.** *Biomphalaria tenagophila* (NHMUK 1854.12.4.264-6). Photographs taken by Johnathan Ablett. Scale bars = 5 mm.

Drepanotrema cimex (Moricand, 1839)

Planorbis cimex Moricand 1839: 139.

Drepanotrema cimex—Paraense and Deslandes 1958b: 187; Paraense 1975a: 111; Paraense 1980: 101; Rumi 1991: 27; Paraense 2005: 492; Rumi et al. 2008: 83; Simone 2006: 102.

Drepanotrema (Fossulorbis) cimex—Baker 1945: 148; Thompson 2011: 66.

Type material. Not located.

Type locality. “les aux douces aux environs de Bahia” (Moricand 1839).

Material examined. ARGENTINA – **Salta** • Anta, El Rey National Park, on the way to Los Lobitos waterfall; 24°42'13.7"S, 064°37'58.8"W; 928 m alt.; 17.III.2009; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD #43 • El Rey National Park, pond on the way to Aguas Negras; 24°42'08.7"S, 064°38'20.6"W, 930 m alt.; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD #48.

Identification. Shell small, with six whorls; basal side slightly convex, with whorls similar in diameter; apical side with all whorls in the same plane. Aperture oblique or elongate and narrow (Fig. 6A). Reproductive system: prostate with short diverticula, with a short duct that joins the spermatid duct, arranged in an orderly row; cylindrical penis sheath, smaller in diameter than the prepuce and ½ the length of the prepuce; two simple flagella, much shorter than of sheath length (Fig. 7A).

Distribution. This species was previously recorded from Santa Fé and Entre Ríos provinces (Rumi 1991; Castellanos and Landoni 1995; Paraense 2005), Buenos Aires (Rumi et al. 1996; Rumi et al. 2008), Corrientes (Rumi 1991; Paraense 2005), and Chaco (Rumi 1991; Paraense 2005). Our new records expand the known distribution of this species in Argentina from the northeast to the

northwest and constitutes the first records of the species from the study area (Fig. 3).

Drepanotrema depressissimum (Moricand, 1839)

Planorbis depressissimus Moricand 1839: 143.

Planorbis (Spiralina) depressissimus—Lutz 1918: 45.

Drepanotrema depressissimum—Baker 1945: 118; Paraense and Deslandes 1957: 339; Paraense 1975a: 111; Paraense 2005: 492; Simone 2006: 102; Rumi et al. 2007: 559.

Drepanotrema depressissimum—Rumi, 1991: 28; Rumi et al. 2008: 83 [incorrect subsequent spelling].

Drepanotrema (Fossulorbis) depressissimum—Thompson 2011: 68.

Type material. Not located. The original label of the probable syntype material was found in the NHMUK, but there was no specimen with it (J. Ablett pers. comm.)

Type locality. Moricand (1839) indicated that this species was “avec le précédent” [= with the preceding] species, *D. cimex*. The type locality of *D. cimex* was given as “San Salvador de Bahía, Brazil.”

Material examined. ARGENTINA – **Jujuy** • Industrial area, on the side of the Provincial Route 56; 25.V.2000; M. Tassara leg., MLP 12880 • pond at the side of route 34 road to Calilegua; 23°33'43"S, 064°23'33"W; 350 m alt.; 15.V.2009; C. Molineri & X.M.C. Ovando leg., BDAD # 99 – **Salta** • General Mosconi, ditch on the side of Route 34; M. Tassara leg., MLP 12898 • El Rey National Park, pond near to Aguas Negras River; 24°41'41.1"S, 064°36'42.8"W; 865 m alt.; 17.III.2009; X.M.C. Ovando leg., BDAD# 38 • same locality above; 24°42'28.7"S, 064°38'20.6"W; 930 m alt.; 17.III.2009; X.M.C. Ovando leg., BDAD# 47 • same locality above, Los Patitos Lagoon; 24°43'59.2"S, 064°38'13.2"W; 886 m alt.; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD # 63 • Urundel, ditch; 23°33'43"S, 064°23'33"W; 816 m alt.; 11.V.2009; X.M.C. Ovando leg., BDAD # 110

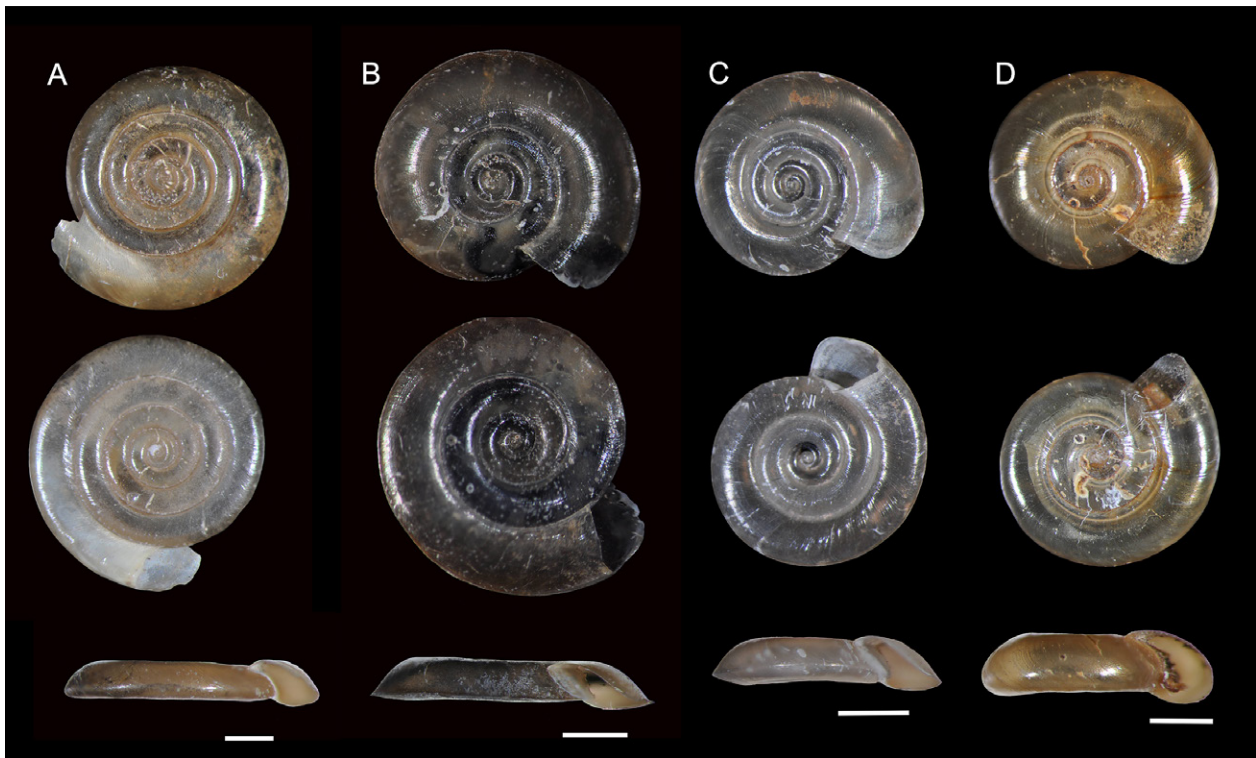


Figure 6. Shells of *Drepanotrema* species reported in Northwestern Argentina (in right, left and side views respectively). **A.** *Drepanotrema cimex*. **B.** *Drepanotrema depressissimum*. **C.** *Drepanotrema kermatoides*. **D.** *Drepanotrema lucidum*. Scale bars: **A–D** 1 mm.

– **Tucumán** • ponds near to Salí River; C. Ituarte leg., MLP 5324-1 • Potrero de Las Tablas, pond on the way to Las Tablas River; 26°51'19.3"S, 065°25'54.0"W; 682 m alt.; M. Mitrovich & X.M.C. Ovando leg., BDAD# 209 • Burruyacú, Rio Nio, stream parallel to the road; 26°25'25.4"S, 064°59'39"W; 940 m alt.; 17.IV.2009; V. Manzo & X.M.C. Ovando leg., BDAD# 84 • Alto de Medina, IFML-MOLL 17020.

Identification. Shell medium-sized, depressed, translucent, with 5¼–6 whorls. Body whorl with a sharp carina, displaced to the left. Aperture triangular, narrow, and oblique. Outer peristomal lip with some concavity and rounded edge; inner peristomal lip straight and shorter than external one (Fig. 6 B). Reproductive system: prostate with elongated, tubular diverticula, similar in size, arranged in an orderly row, except for those near the copulatrix bursa. Penial complex with two well-developed flagella, one slightly longer than the other; flagellum length 2–3 times greater than length of the penis sheath (Fig. 7 B).

Distribution. This species was previously recorded from Santa Fé, Entre Ríos (Rumi 1991; Castellanos and Landoni 1995), Corrientes, Chaco, and Misiones (Rumi 1991; Paraense 2005). Our new records from show that this species also inhabits the NOA region.

Drepanotrema kermatoides (d'Orbigny, 1835)

Planorbis kermatoides d'Orbigny 1835:27.

Drepanotrema kermatoides—Paraense and Deslandes 1958c: 293; Bonetto et al. 1982: 1; Rumi 1991: 30; Rumi et al. 2007: 559; Rumi et al. 2004: 453; Paraense 2005: 492; Simone 2006: 103.

Gyraulus (*Drepanotrema*) *kermatoides*—Haas 1949: 301.

Drepanotrema (*Fossulorbis*) *kermatoides*—Baker 1945: 148; Thompson 2011: 68.

Type material. Syntypes (NHMUK 1854.12.4.276). 10 specimens.

Type locality. “provincia Limacensi (republica Peruiana)” (d'Orbigny 1835).

Material examined. ARGENTINA – **Salta** • Anta, El Rey National Park, Los Patitos Lagoon; 24°43'59.2"S, 064°38'13.2"W; 886 m alt.; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD # 52 • Orán, Pescado River; 22°57'28.5"S, 064°23'6.7"W; 350 m alt.; 10.V.2009; X.M.C. Ovando leg., BDAD # 143– **Tucumán** • Trancas, El Boyero watering place, ponds near to Salí River; M.G. Cuezco leg., BDAD # 4 • Chichigasta, La Cruz stream; 27°01'34"S, 065°23'36"W; 370 m alt.; 23.II.2009; X.M.C. Ovando leg., BDAD # 31 • Simoca, Manuela Pedraza, route157; 27°12'18"S, 065°21'28"W; 330 m alt.; M.G. Cuezco leg., BDAD # 56.

Identification. Shell with 5½–6 whorls; basal side slightly convex; periphery of the body whorl with carina, tending to be on the left side. Aperture falciform, longer than wide; inner peristomal lip convex, slightly depressed, and oblique; external peristomal lip almost straight (Fig. 6 C). Reproductive system: penis complex with two very short flagella in proportion to the sheath at the insertion of the vas deferens (Fig. 7 C).

Distribution. There are numerous Argentine records of this species, indicating a widespread distribution. It is known from Entre Ríos, Santa Fe, and Buenos Aires (Rumi 1991; Rumi et al. 1996, 2008), Rio Negro, (Paraense 2005; Castellanos and Landoni 1995), Corrientes

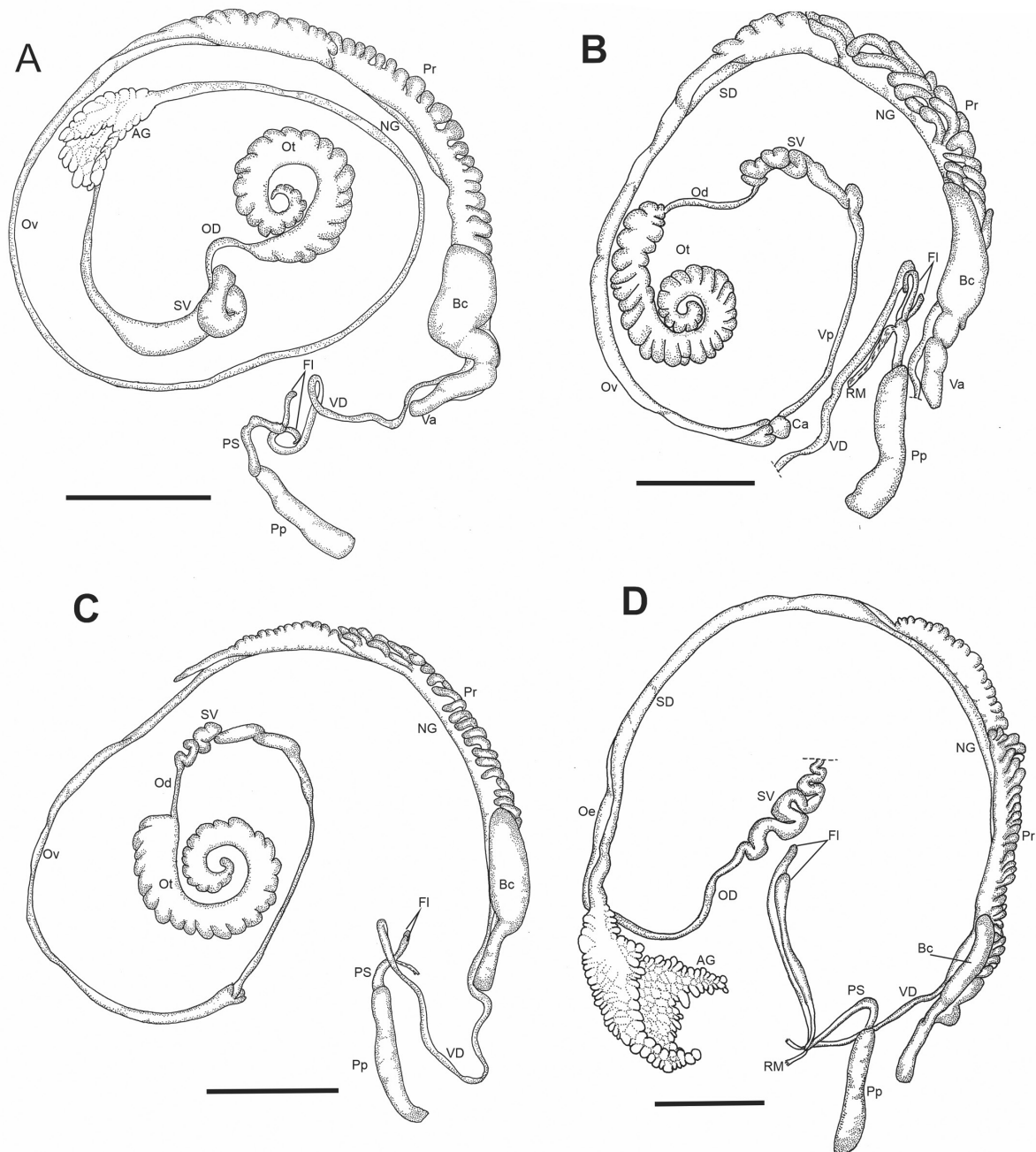


Figure 7. Reproductive system of *Drepanotrema* species. **A.** *Drepanotrema cimex*. **B.** *Drepanotrema depressissimum*. **C.** *Drepanotrema kermatoides*. **D.** *Drepanotrema lucidum*. Abbreviations: AG albumen gland, Bc bursa copulatrix, Ca carrefour, FI flagellum, NG nidamental gland, OD ovisperm duct, Ov ovi duct, Ot ovotestis, Pp prepuce, PS penis sac, RM retractor muscle, SD sperm duct, SV seminal vesicle, Va vagina, VD vas deferens. Scale bar **A–D**: 1mm.

(Rumi 1991; Paraense 2005), and Misiones (Rumi 1991; Castellanos and Landoni 1995). Paraense (2005) reported this species from Tucumán. Our new records from Tucumán and Salta provinces increases the known distribution of this species in the area.

Drepanotrema lucidum (Pfeiffer, 1839)

Planorbis lucidus Pfeiffer 1839: 354.

Drepanotrema lucidum—Paraense 1975a: 105; Rumi 1991: 31; Rumi et al. 2007: 559; Paraense 2005: 492; Simone 2006: 104.

Type material. Not located.

Type locality. Cuba (Pfeiffer 1839).

Material examined. ARGENTINA – **Salta** • El Rey National Park, ponds on the way to Aguas Negras; 24°42'28.7"S, 064°38'20.6"W; 930 m alt.; 17.III.2009; X.M.C. Ovando leg., BDAD# 59 • La Escondida lagoon; 24°42'15"S, 064°39'6.8"W; 925 m alt.; 19.III.2009; E. Pero, M.G. Cuezco & X.M.C. Ovando leg., BDAD # 44 • Urundel, ditch; 23°33'43"S, 064°23'33"W; 316 m alt.; 11.V.2009; X.M.C. Ovando leg., BDAD # 110.

Identification. Shell small, 4.4–7 mm in diameter, with 5 or 6 whorls. Body whorl prominent and subangular.

Apical and basal sides of the shell flattened, with the apical side slightly more convex. Aperture sickle-shaped, higher than wide; right parietal lip flattened and obliquely (Fig. 6 D). Reproductive system: flagella well developed, slender, long, and one slightly longer than the other; length of longer flagellum $3\frac{1}{2}$ times longer than penis sheath (Fig. 7 D).

Distribution. This species has been reported from Santa Fé and Entre Ríos provinces, Chaco (Castellanos and Landoni 1995), Entre Ríos (Rumi 1991; Paraense 2005), and Misiones (Rumi 1991; Castellanos and Landoni 1995; Rumi et al. 2008). Despite exhaustive fieldwork, most records are concentrated in the province of Salta.

Drepanotrema nordestense (Lucena, 1954)

Planorbis pfeifferi Strobel, 1874: 105 [junior homonym of *Planorbis pfeifferi* Krauss, 1874].

Tropicorbis nordestensis Lucena 1954: 329 [new name for *P. pfeifferi* Strobel, 1874].

Drepanotrema nordestense—Paraense and Deslandes 1958d: 275; Pointier et al. 2001: 7.

Antillorbis nordestensis—Paraense 1975: 105; Rumi 1991: 15; Santos et al. 1999: 257; Paraense 2005: 491; Rumi et al. 2008: 82.

Type material. Holotype (MZSP 46029). Paratypes (MZSP 46030–46063, 64102).

Type locality. “Águas Belas, Pernambuco, Brasil” (Lucena 1954).

Material examined. ARGENTINA – **Jujuy** • tributary stream of the Reyes River; 24°10'46"S, 65°28'18"W; M.G. Cuezco leg., BDAD# 252 – **Tucumán** • Raco, near to Potrero de Las Tablas River; 880 m alt.; M.G. Cuezco leg., BDAD # 261 • Trancas, in stream passing Pozo del Pescado; 26°11'22.3"S, 65°17'02.1"W; 789 m alt.; 15.XI.2011; X.M.C. Ovando leg., BDAD# 238.

Identification. Shell small, with four whorls. Body whorl prominent, shifted to the left. Apical side flat to slightly concave, almost all whorls in the same plane. Basal side excavated, forming a deep cavity. Aperture oval, wider than high, and with edge expanded.

Distribution. Paraense (2005) had reported this species from Entre Ríos, Buenos Aires, and Rio Negro. Our new records are the first from the study area.

Discussion

This work summarizes the distribution of nine species of Planorbinae in northwestern Argentina. We add new occurrence data from the NOA region for four species of *Biomphalaria* and five of *Drepanotrema*, and we record some species in the region for the first time. Both *Biomphalaria* and *Drepanotrema* species were collected in in the Sali-Dulce and San Francisco river basins. These river basins are subjected to strong anthropic pressures from the main cities and industries, as well as from agriculture and livestock (Nieto et al. 2017).

Biomphalaria straminea was recorded for first time in Salta province in the Pescado River (Orán department). This site is in the transitional area between the

Yungas Rainforest and Gran Chaco regions where intensive deforestation and land transformation for crops are concentrated (Seghesso et al. 2011). “Criollos” (local inhabitants of predominantly European descent) and indigenous people living in the area mostly lack access to clean drinking water and basic sanitation. Echazú et al. (2015) described inadequate sanitation and unsafe water supply as risk factors for parasitic human infection. In Brazil, this species is a natural host of *Schistosoma mansoni*, which causes schistosomiasis and affects approximately 6 million people (Martins et al. 2015). Paraense (2005) recorded this species in Jujuy province and gave the city of San Salvador de Jujuy as a generalized locality without specifying an exact collection site. Others records of this species are from central (Córdoba) (Rumi 1991; Castellanos and Landoni 1995; Paraense 2005) and northeastern Argentina (Entre Ríos and Corrientes).

Biomphalaria tenagophila was recorded in all the river basins in the study area. It was also the species most frequently found. This species is susceptible to infestation by *Schistosoma*. Experimental studies of populations of *B. tenagophila* from Argentina, Uruguay, and Paraguay have demonstrated that this species is susceptible to the Brazilian strain of *S. mansoni* (Borda and Rea 1997, 2007). According to Rumi et al. (2008), *Biomphalaria peregrina* is the most widespread species in Argentina and is a potential host of *S. mansoni* (Rumi 1991). Despite the existence of schistosomiasis foci in the Brazilian states bordering Argentina, Uruguay, and Paraguay, there have been no reports of the natural transmission of schistosomiasis in Argentina (Simões et al. 2013); however, the numerous records of *B. tenagophila* in the study area are of concern for villages where the species has been found.

Records of *Biomphalaria orbignyi* were concentrated in the Sali-Dulce river basin, Tucumán province. This species was previously recorded by Paraense (1975) from the Chaco Salteño area in eastern Salta province. This area is part of the Great American Chaco (the second largest tropical forest in the American continent after the Amazon). Rivers from higher ground cross the area, flowing into the Bermejo River, which is a major river flowing south from its origins in Bolivia to the Paraná River far to the southeast (Grau et al. 2010).

The genus *Drepanotrema* occurs through most of South America, south to Río Negro province in Argentina (Castellanos and Miquel 1991; Rumi 1991), with some species occurring north to southern Texas, United States (Baker 1945). According to Rumi et al (2007), the genus includes six species in Argentina, and they form part of the most frequent freshwater snail associations. In the study area, we reported four species and at some collecting points, *D. kermatoides* was collected in association with *Biomphalaria straminea*. *Drepanotrema cimex* and *D. nordestense* were record for first time in the northwestern Argentina. *Drepanotrema cimex* was recorded in the El Rey National Park, protected area in the province of Salta. Previous records of this species

are concentrated in northeastern Argentina (Paraense 2005). Although not of interest in the epidemiology of schistosomiasis, *D. cimex* is a potential host of cercariae and is therefore of veterinary interest (Thiengo et al. 2001). *Drepanotrema nordestense* has been sporadically recorded in Argentina; Rumi (1991), Castellanos and Landoni (1995), and Rumi et al. (1996) mentioned it from Buenos Aires and Santa Fé provinces. It is possible that due to its small size, this species has gone unnoticed, and its distribution is wider. Paraense (2005) found it in several habitats, such as lakes, ponds, and streams, in Entre Rios and Rio Negro.

The presence of species of medical interest in the NOA region gives reason to continue fieldwork and analyze the presence of parasites. Additional studies sampling effort should focus on Santiago del Estero and Catamarca provinces to obtain a better understanding of the species of Planorbinae that inhabit the NOA region.

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Authors' Contributions

Conceptualization: XMCO. Data curation: XMCO, GM. Investigation: XMCO. Supervision: XMCO. Methodology: GM. Writing – original draft: XMCO. Writing – review and editing: XMCO.

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