



Revista Mexicana de Biodiversidad

ISSN: 1870-3453

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Universidad Nacional Autónoma de México
México

Naranjo García, Edna; Willibaldo Thomé, José; Castillejo, José
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Revista Mexicana de Biodiversidad, vol. 78, núm. 1, junio, 2007, pp. 41-50
Universidad Nacional Autónoma de México
Distrito Federal, México

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A review of the Veronicellidae from Mexico (Gastropoda: Soleolifera)

Revisión de los Veronicellidae de México (Gastropoda: Soleolifera)

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Resumen. Se sintetiza la información conocida de los Veronicellidae de México. Los datos provienen de ejemplares depositados en la Colección Nacional de Moluscos, Instituto de Biología, Universidad Nacional Autónoma de México, de salidas complementarias de trabajo al campo y recopilación de la literatura. Estas babosas se distribuyen principalmente en el centro y sur de México, aunque existen algunos registros en el norte del país. Se han registrado 3 géneros y 5 especies: *Leidyula floridana*, *L. moreleti*, *Phyllocaulis gayi*, *Sarasinula dubia*, y *S. plebeia*. Los registros en México de *L. floridana* y *P. gayi* deben confirmarse. En la región de Los Tuxtlas, al sur del estado de Veracruz, se localizó un foco donde las babosas Veronicellidae son plaga, los agricultores dejaron de sembrar frijol y cambiaron a otros cultivos para evitar la plaga.

Palabras clave: babosas terrestres, distribución, nativas, introducidas, plaga.

Abstract. Information is presented regarding the species of the Family Veronicellidae in Mexico. Data were gathered from specimens deposited in the Colección Nacional de Moluscos (Instituto de Biología, Universidad Nacional Autónoma de México), from field trips, and from the literature. These slugs are distributed mainly in the central and southern regions of Mexico, although there are a few records from the northern part of the country. Five species in three genera have been recorded, namely: *Leidyula floridana*, *L. moreleti*, *Phyllocaulis gayi*, *Sarasinula dubia* and *S. plebeia*. The occurrence of *Leidyula floridana* and *Phyllocaulis gayi* in Mexico needs confirmation. The Los Tuxtlas region, southern Veracruz, is a hotspot where veronicellid slugs have become a pest and farmers have stopped growing beans, switching to other crops as a measure to contain the pest.

Key words: slugs, terrestrial, distribution, native, introduced, pest.

Introduction

A review of the literature shows that there are few records of the Veronicellidae from Mexico. The earliest records are found in general reports such as those by Fischer and Crosse (1870-1878) and von Martens (1890-1901). *Leidyula moreleti* (Fischer, 1871) was the first species of Veronicellidae recorded from Mexico (Fischer and Crosse, 1870-1878; von Martens, 1890-1901; Baker, 1925; Bequaert and Clench, 1936; Thompson, 1967).

In 1925, Hoffman recorded a second member of the Veronicellidae in Mexico, *Phyllocaulis gayi* (Fischer, 1871). Much later, Andrews and Dundee (1987) mentioned the presence of *Sarasinula plebeia* (Fischer,

1868) for the first time as a pest on bean crops in Chiapas, Veracruz and Yucatán. Thomé (1989) in his checklist of the Veronicellidae from the Antilles, Central and North America, confirmed the record of *S. plebeia* in Mexico and added *Sarasinula dubia* (Semper, 1885). Contreras-Arquieta, in 1995 recorded *Leidyula floridana* (Leidy in Binney, 1851) from the state of Nuevo León.

The aim of this study is to bring together all the information available on the family Veronicellidae in Mexico.

Material and methods

The literature was studied as well as the Colección Nacional de Moluscos of the Instituto de Biología, Universidad Nacional Autónoma de México, Mexico

City, and the material from Chiapas in the Invertebrate Zoology Collection at the California Academy of Science. The vicinities of Los Tuxtlas, Veracruz; Mazatlán city, Sinaloa and the outskirts of Mérida, Yucatán, were visited in search of slugs to add further information (Table 1).

Abbreviations used in the text are: CASIZ = California Academy of Science Invertebrate Zoology Collection. California, NMNH = National Museum of Natural History, Smithsonian Institution, United States of America. EAP = Escuela Agrícola Panamericana, Zamorano, Honduras. MCN = Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, RS, Brazil. SMF = Senckenberg Museum, Frankfurt and ZMB = Zoologisches Museum Berlin, Germany. CNMO = Colección Nacional de Moluscos, Instituto de Biología, Universidad Nacional Autónoma de México, México.

Slugs were collected under rocks, fallen tree trunks, leaf litter and other shaded, damp habitats. Flashlights were used at night. As soon as slugs were caught, photographs were taken *in situ* to obtain the best record of body color and natural appearance. In order to relax them, they were placed in large containers, filled with boiled cold water and a small amount of tobacco. The container was then tightly closed and placed in a cool place for two to four hours, then in the refrigerator at 4°C for two to several days, until the slugs showed no reaction to mechanical stimuli. They were then transferred to and preserved in 70% alcohol (neutralized with borax).

Study of the reproductive anatomy is required for species identification, especially the following organs: pedal gland, penial gland, penis, spermatheca and prostate gland. Dissections were made in wax – bottomed dissecting dishes using ophthalmological scissors and entomology needles.

Results

Leidyula floridana (Leidy & Binney in Binney, 1851)
Vaginulus floridanus Leidy & Binney in Binney, 1851
 Binney, A. 1851. The Terrestrial Air-breathing Mollusks of the United States and the adjacent territories of North America. Volume I. A.A. Gould (ed.). Charles C. Little and James C. Brown, Boston, MA. 366 pp. (198, 251, pl. IV).

Vaginulus floridanus Leidy, 1851 (Binney, 1851)
Vaginulus floridanus Binney, 1851 (Binney, 1885)
Veronicella floridana (Binney, 1851) (Binney, 1885)
Leidyula floridana (Leidy & Binney in Binney, 1851) (Thomé et al., 1997)

Taxonomic summary

Type. Holotype NMNH 180860 (alcohol preserved), Robert Hershler, Curator of Mollusks (pers. comm. 2006).

Type locality. Punta Rassa, Florida, United States of America (Pilsbry, 1948:1063); however, according with Thomé (1989) the type locality is Meta-lee-chee-Key, Charlotte Harbor, Florida, United States of America.

Distribution. Chiapas: at Río Coatancito, Tapachula, 16 July 1990. Nuevo León State: Río Hualahuises, at junction with Río Camiono, Hualahuises, 10 July 2003; Río Pilób, Presa Los Magueyes, Km 118 Cd. Victoria-Linares, 10 November, 1991; Cerro de la Silla, Guadalupe, April, 1991; Presa La Boca, Santiago, 15 August 1988, 12 June 1981 and Las Adjuntas, Santiago, 1990. Veracruz State: Tlapacoyan, 8 February 1988 and Poza Rica, 1990 (Contreras-Arquieta, 2003, pers. comm.) (Table 1).

Ecological notes. *Leidyula floridana* has not been reported as a pest in Nuevo León (Contreras, 1995 and 2003, pers. comm.); however, it is a known pest on potatoes in Cuba and on beans and tomatoes in other places (Andrews and Dundee, 1987).

Remarks

Leidyula floridana was found at various places in the state of Nuevo León by Contreras-Arquieta (1995, 2003, pers. comm.) (Table 1), but he did not comment on special features of the species. Particular importance should be given to Contreras-Arquieta's records of *L. floridana* in Tlapacoyan, Veracruz and Tapachula, Chiapas, since these places are far from Nuevo León. Tlapacoyan is located around the central part of Veracruz state and Tapachula in the southern part of Chiapas (this last site lies over 2000 km from Nuevo León). Such records need identity confirmation since *Leidyula floridana* has been cited as a recent record from Nicaragua and also as a pest (Andrews and Dundee, 1987).

Leidyula floridana could be considered as native due to the fact that great tracts of the country have not been collected, and it was only in the past few decades that the species was recorded. An alternative scenario is that the species was introduced (distribution data collected from various museums by Thomé et al. -1997- recorded the slug from Florida, Texas, Puerto Rico, USA; Cuba and Dominica, with the collection dates varying from 1899 to 1979).

Leidyula moreleti (Fischer, 1871)
Vaginula moreleti Fischer, 1871
 Fischer, P. 1871. Révision des espèces du genre *Vaginula* Férussac. Nouvelles Archives du Muséum d'Histoire Naturelle. Paris, vol. 7:147-175.

Table 1. Species of Veronicellidae found in Mexico according to records from the literature and personal communication.

State	Locality	Lf	Lm	Pg	Authority
Campeche	Isla del Carmen 18° 50' N, 91° 20' W		X		Fischer and Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925; Thompson, 1967, Thomé et al., 1997
	Not given		X		Thomé et al., 1997
Chiapas	Palenque		X		Fischer and Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925; Thomé, 1971
	Río Coatancito, Tapachula				Contreras-Arquieta, 2003, pers. comm.
Nayarit	Tepic		X		Baker, 1925
Nuevo León	Río Hualahuises, at junction with Río Camiono	X			Contreras-Arquieta 2003, pers. comm.
	Río Pilólb, Presa Los Magueyes, Km 118 Cd. Victoria-Linares	X			Contreras-Arquieta, 2003, pers. comm.
	Cerro de la Silla, Guadalupe	X			Contreras-Arquieta, 2003, pers. comm.
	Presa La Boca, Santiago	X			Contreras-Arquieta, 2003, pers. comm.
	Las Adjuntas, Santiago	X			Contreras-Arquieta, 2003, pers. comm.
Oaxaca	Cacoprieto		X		Fischer and Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925; Thomé, 1971
	Tehuantepec		X		Baker, 1925
San Luis Potosí	Mecos		X		Baker, 1925; Thomé et al., 1997
	Tamazunchale		X		Thomé et al., 1997
	Huchihuayan		X		Thomé et al., 1997
	Valles		X		Baker, 1925
	6 km after Xilitla		X		Correa, 1997
San Luis Potosí	1 km NW Tamasopo		X		Correa, 1997
	Agua Buena				Correa, 1997
Sinaloa	Mazatlán			X	Baker, 1925; Hoffman, 1925
Tabasco	Non given		X		Baker, 1925; Deisler and Phelps, 1985; Thomé et al., 1997
Veracruz	Tuxpan - Poza Rica road km 234		X		Correa, 1997
	Hacienda Cuatutolapan		X		Baker, 1923, 1925; Thomé et al., 1997
	Tlapacoyan	X			Contreras-Arquieta, 2003, pers. comm.
	Poza Rica	X			Contreras-Arquieta, 2003, pers. comm.
Yucatán	Aguada 14 km N and 2 km E of Mérida; 1.6 km N of Mérida		X		Bequaert and Clench, 1936

Symbols: Lf = *Leidyula floridana*, Lm = *Leidyula moreleti*, Pg = *Phyllocaulus gayi*.

Vaginulus kreideli Semper, 1855 (Thomé, 1989)
Leidyula moreleti (Fischer, 1871) (Thomé, 1971; Thomé et al., 1997)
Veronicella (Leidyula) moreleti (Crosse and Fischer, 1872) (Baker, 1925)
Vaginulus mexicanus Strebel and Pfeffer, 1882 (Thomé, 1989)

Taxonomic summary

Type. Thomé (1971) designated figures 5 and 6 of plate 11 of Fischer's 1871 work as holotype, since the specimen used by Fischer to describe the species is missing from the Museum National d'Histoire Naturelle, Paris, France (Thomé, 1971).

Type locality. Palenque, Chiapas (known by previous authors under the name of Tabasco as Baker, 1925) Mexico (Thomé, 1971). Thomé (1971) received three specimens from the Museum National d'Histoire Naturelle, Paris, France, for which the locality was Cacoprieto (Tehuantepec), collected by Sumichrast, Thomé (1971) chose one from that lot to re-describe the species.

Diagnosis. The basal section of the penis in our specimens is cylindrical and the apical section (glans penis) has the hardened tissue and twisted tip in accordance with the description of *L. moreleti* given by Caballero et al. (1991).

Distribution. It has been recorded from Isla del Carmen, Campeche (Fischer & Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925; Thompson, 1967 and Thomé et al., 1997); Palenque, Chiapas (Fischer & Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925); Tepic, Nayarit (Baker, 1925); Cacoprieto (Fischer & Crosse, 1870-1878; Martens, 1890-1901; Baker, 1925) and Tehuantepec, Oaxaca (Baker, 1925); Mecos (Baker, 1925, Thomé et al., 1997), Tamazunchale and Huichihuayan (Thomé et al., 1997), Valles (Baker, 1925); 6 km after Xilitla, 1 km NW Tamasopo and Agua Buena, San Luis Potosí; Carr. Tuxpan – Poza Rica Km 234 (Correa, 1997); Hacienda Cuatrotolapan, Veracruz (Baker, 1923, 1925; Thomé et al., 1997); Aguada 14 km N and 2 Km E of Mérida; 1.6 km N of Mérida, Yucatan (Bequaert and Clench, 1936) (Table 1).

Ecological notes. *Leidyula moreleti* was found by Baker (1923) in all types of habitats (lowland jungles, open savanna); our collecting was done at night, slugs were crawling on the concrete walls that contain the ornamental plants in the garden at the Los Tuxtlas Biological Station. This garden is surrounded by tropical rain forest. Also, slugs collected at Facultad de Veterinaria y Zootecnia, Universidad Autónoma de Yucatán (located on what was previously tropical deciduous forest), were found at night among moist litter around the garden. *Leidyula moreleti* shared its habitat with *Sarasinula plebeia* in the gardens of the Biological Station at Los Tuxtlas.

Leidyula moreleti has been recorded as a pest at two localities in Mexico, a coffee plantation in the state of Tabasco (no specific locality given) (Deisler and Phelps, 1985) and in “cacao” crops (no locality given). It is also a pest on citrus trees in Florida (Andrews and Dundee, 1987). Deisler and Phelps (1985) consider that *Leidyula moreleti* causes six times more damage to plants (leaves) than *Angustipes ameghini* (Gambetta, 1923) and also that its spread within the United States of America will probably be less rapid because *L. moreleti*, as a viviparous slug, will not distribute eggs via the plant trade.

Remarks

Although, Baker (1923) collected the slugs in apparently undisturbed habitats, he also found them in grassy areas and close to sugar cane plantations. Remarkably, the specimens found by us were always around man-made dwellings (or disturbed habitats).

In the gardens of the Los Tuxtlas Biological Station, *Leidyula moreleti* and *Sarasinula plebeia* were more abundant than at any other place visited.

New records. VERACRUZ, Los Tuxtlas Biological Station, 30 km NNW by road from Catemaco town, garden surrounded by the station buildings. 18° 35.11'N, 95° 04.45'W. J. Castillejo, O.J. Polaco and E. Naranjo. 15 and 18 May 1997. CNMO 642. YUCATÁN, km 15.5 on Mérida-X'matkuil road, S Mérida. At Facultad de Veterinaria y Zootecnia, Universidad Autónoma de Yucatán installations. Mollusks course. 9 June 1997. CNMO 638.

Phyllocaulis gayi (Fischer, 1871)

Vaginula gayi Fischer, 1871

Fischer, P. 1871. Révision des espèces du genre *Vaginula* Férussac. Nouvelles Archives du Muséum d'Histoire Naturelle. Paris, vol. 7:147-175.

Vaginula (Phyllocaulis) gayi Fischer, 1871 (Baker, 1925)

Phyllocaulis gayi (Fischer, 1871) (Thomé, 1971)

Taxonomic summary

Type. Forcart in 1952 designated the Lectotype, such specimen lacks a catalogue number and is housed at the Museum National d'Histoire Naturelle, Paris, France (Thomé, 1971).

Type locality. Valdivia, Chile (Thomé, 1971).

Distribution. Sinaloa: Mazatlán (Hoffmann, 1925:170, 245; Baker, 1925) (Table 1).

Ecological notes. *Phyllocaulis gayi* lives in temperate forest in southern Chile (Thomé, 1976), and although general knowledge considers slugs as herbivores, Simonetti et al. (2003) observed *P. gayi* feeding in the field on seeds of the exotic *Arachis hypogaea*; in addition, in laboratory experiments it consumed seeds of the native trees *Cryptocarya alba* and *Aetoxicum punctatum* (Simonetti et al., 2003); in the opinion of these authors, *P. gayi* should be considered a potential seed predator in forest regeneration and should be monitored carefully.

Remarks

The genus *Phyllocaulis* contains several species distributed only in Argentina, Brazil, Chile and Uruguay (Thomé, 1976). *Phyllocaulis gayi* is the only species of the

genus found on the Pacific side of South America, thus it is highly possible that a slug from Chile was introduced to the city of Mazatlán, Sinaloa, a major port on the Pacific coast of Mexico (Baker, 1925). Thomé (1976) states that Hoffman's (1925) Mexican record from Mazatlán is an accidental introduction of the species due to human economic activity.

A search of *Phyllocaulis gayi* around the main square at Mazatlán City, July 2006, did not secure a single specimen; gardens had sandy soil and were devoid of litter – conditions recommended to prevent the spreading of mollusks.

Sarasinula plebeia (Fischer, 1868)

Vaginulus plebeius Fischer, 1868

Fischer, P. 1868. Diagnoses de deux Limaciens de la Nouvelle Calédonie. Journal de Conchyliologie, Paris. vol. 16:145-146.

Vaginula plebeja Fischer, 1868 (Aguayo, 1964)

Sarasinula plebeja Grimpe and Hoffman, 1925 (Thomé, 1971)

Vaginula behni Semper, 1885 (Thomé, 1989)

Sarasinula lemei Thomé, 1967 (Thomé, 1989)

Sarasinula plebeia Thomé, 1993, Thomé et al., 1997

Taxonomic summary

Type. Thomé (1971) designated figure 9 of plate number 11 of Fischer's (1871) work as Holotype; this author decided to declare the illustration a holotype since E. Marie, the illustrator, based the design of the drawing on the material studied by Fischer. Thomé (1971) also re-described the species with material from the Museum National d'Histoire Naturelle, Paris, France. He designated as a plesiotype a specimen with the following information: “*Vaginula plebeia* Fisch., N. elle Calédonie – M. Fischer and *Vaginula plebeia* Fischer, N. elle Calédonie – (Fischer)” (Thomé, 1971).

Type locality. Nouméa (Gomes and Thomé, 2001), New Caledonia (Thomé, 1971).

Diagnosis. the specimens studied show the following morphological characters: the penis possess a “cobra” glans penis morphology, an accessory bursa is lacking, and the penial gland is elongated in agreement with the characters given by Caballero et al. (1991).

Distribution. Mérida, Yucatán (Andrews and Dundee, 1987); México, EAP-840823.01 (Thomé, 1989:23).

Ecological notes. *Sarasinula plebeia* shares the same habitat with *Leidyula moreleti* at the gardens of the Los Tuxtlas Biological Station; external examination of the slugs is not useful for separating the two species in the field.

In farming land the slug eats young plants down to soil level, legume pods and sometimes flowers. During the dry season, the slugs bury themselves to a depth of up to 25 cm or to 1 meter (Pitty and Andrews, 1990); banana leaves and “tiquisque” (*Xanthosoma saguitifolium* sic) shelter the slugs from being damaged (Rodríguez, 1987). The slug's radula has a tasty inclination for *Ipomea batatas* and *Brassica oleracea* (Andrews and Valverde, 1985), *Cucurbita* sp., *Lycopersicon esculentum* – tomato and *Borreria* sp. (Rodríguez, 1987). In field experiments in small plots of cultivated corn and beans with broad leaved weeds and situated close to a stream, the slug population increased slowly the first 10 weeks then exploded from week 11 to 14, coincident with heavy and continuous rain. The slugs reached maturity at an age of 2.5 months. Sowing of bean plants reduced the population (Andrews and Lema, 1986).

Sarasinula plebeia is a pest in plant nurseries cultivating mahogany and red cedar trees in south central Veracruz (Los Tuxtlas region). Farmers (Cooperativa Cintepec, pers.com.) stopped growing beans and changed crops due to the severity of the slug problem. Farmers believed that the slug came from the north between 1967 and 1972. Their estimate of the introduction of *S. plebeia* to the region is thus earlier than that of Andrews and Dundee (1987) who reported that it had reached pest status in the same region of Veracruz by 1981. In Honduras, *S. plebeia* also became a problem, forcing farmers to stop growing beans and having to switch to alternative crops (Pitty and Andrews, 1990; Caballero et al., 1991). This slug has been a pest since 1967 in el Salvador, then appeared in Nicaragua (1975), Costa Rica (1980), Guatemala (1981), Panama (1984) and by 1984 there was a single record from Belize (Andres and Dundee, 1987).

Remarks

In Texas introduced populations of *Sarasinula plebeia* occur close to human habitation where the watering of plants provides the necessary humid conditions for its survival. It can endure sub-freezing temperatures and re-build its population within two months and one week suggesting (Neck, 1990) that *S. plebeia* is cold tolerant. Andrews and Dundee (1987) observed that at 1000 m altitude in Central America, the species caused less damage than at lower elevations. The risk of this species of slug becoming established in more human settlements is easily appreciated bearing in mind its ample range of temperature tolerance, especially with the help of human activities such as the introduction and watering of exotic plants.

Thomé (1989) and Caballero et al. (1991) have suggested that *S. dubia* (Semper, 1885) and *S. plebeia*

(Fischer, 1868) might be synonyms. Should this be the case, *S. plebeia* will be seen to have spread over wide areas of the southern half of Mexico.

New records. SAN LUIS POTOSÍ, Pueblo Tamasopo, Ca. 26 km w, 7 km s Cd. Valles. 21° 55' 5.7" N, 99° 23' 45" W. Among rocks and wooden material lying along street. E. Naranjo. 7 July 1997. CNMO 1072. VERACRUZ, Municipio Catemaco, ca. 6.5 km S and 4 km E of Catemaco. 18° 21' 37.3" N, 95° 04' 37.7" W, Vivero "El Platino", Plant Nursery of Gobierno del Estado. In plant nurseries and palma camedor (*Chamaedorea* sp.). J. Castillejo, O.J. Polaco and E. Naranjo. 16 May 1997. CNMO 640. VERACRUZ, Municipio Catemaco, Zapopan de Cabañas. Ca. 12 km S and 4 km E of Catemaco, on the road Zapopan – El Aguila, Cooperativa Cintepec. 18° 19' 11" N, 94° 59' 12" W. J. Castillejo, O.J. Polaco and E. Naranjo. 17 May 1997. CNMO 636.

VERACRUZ, Los Tuxtlas Biological Station, 30 km NNW by road from Catemaco town, garden around station buildings. 18° 35.11' N, 95° 04.45' W. J. Castillejo, O. J. Polaco and E. Naranjo. 16 May 1997. CNMO 637. VERACRUZ, Los Tuxtlas Biological Station. L.J. Rangel R. 14 November 1984 CNMO 639. YUCATÁN, Mérida. House garden. J.M. Gómez. 12 and 13 June 1997. CNMO 635.

Sarasinula dubia (Semper, 1885)

Vaginulus dubia Semper, 1885

Semper, C. 1885. Landmollusken. In: Reisen im Archipel der Philippinen. Weisbaden, C.W. Kreidel. Part 2, vol. 3 (7): 291-327, pl. 24-27.

Veronicella discrepans Thiele, 1927 (Thomé, 1989)

Taxonomic summary

Type. Lectotype housed at the Zoologisches Museum, Berlin (ZMB-39057a).

Type locality. St. Thomas, Virgin Islands.

Diagnosis. The morphological characters of our specimens agree with those seen in *S. dubia* on the penis, penial gland and pedal gland. The penis is short with a lanceolate glans penis, an accessory bursa is lacking, the penial gland is a conus that appears to be flattened on the sides, the pedal gland is long and narrow, slightly bent at the middle in accordance with the characters illustrated for the species by Thomé (1989).

Distribution. Mexico, without specific locality data, MCN-8889, 8890; EAP-870923.01, 851130.01 (Thomé, 1989).

Ecological notes. The species was found under rocks and piles of logs close to human dwellings (Tamasopo); under decaying litter on a banana plantation (Cuitláhuac); crawling about on the sidewalk close to an empty grassy lot early morning after rain the night before (Jalpan), and

crawling on moist soil and under pots in a nursery, in the rain (Mazatlán) (data taken from specimens at CNMO). Also, in urban areas in the humid early mornings or late nights during the wet season, July and August (Puerto Vallarta) (Cupul, 2005).

Remarks

It was not surprising to find veronicellid slugs (*Leidyula moreleti*, *Sarasinula plebeia* and *S. dubia*) on disturbed habitats or close to humans since introduced slugs might have reached the country as eggs on soil with exotic plants or as adults buried in the soil. Exotic plants have accompanied humans since the early discovery of the Americas. Indeed it seems that modern methods of transportation rapidly increase plant distribution ranges, favoring slugs dispersal.

Hoffman (1925) placed *Vaginulus dubius* as a synonym of *Sarasinula plebeia* though Baker (1925:179) disagreed. However, later on Aguayo (1964) also placed *Sarasinula dubia* as a synonym of *S. plebeia*, then Thomé in 1989 stated that *Sarasinula plebeia* exhibited two variations of penis morphology which correspond to the descriptions of both *S. plebeia* and *S. dubia* which should thus be considered synonyms. He also mentioned that two of his students were performing electrophoretic and genetic studies on four *Sarasinula* species (*S. plebeia*, *S. dubia*, *S. marginata* and *S. linguaeformis*) to resolve the issue.

New records. COLIMA, Callejones. 18° 47' 52.8" N, 103° 38' 28.6" W, Mariel Familiar-López, 21 junio 2006, CNMO 1727. CHIAPAS, ca. 1 km E of Finca Custepec, at E side of river Custepec. M.T. Olivera, 11 May 1991. CNMO 173. CHIAPAS, 5 km W of Cañada Teopisca, C. Beutelspacher, 22 October 1992. CNMO 271. JALISCO, Municipio El Guallo, El Grullo City, 19° 41' 30" -19° 53' 50" N, 104° 19' 35" - 104° 53' 50" W; house garden. Linda Palafox, 18 June 1993. CNMO 559. JALISCO, Municipio La Huerta, Pueblo Careyes, km 54 on the federal road 200, Barra de Navidad – Puerto Vallarta. Ricardo Ayala, 9 October 1992. CNMO 414. JALISCO: Puerto Vallarta, city gardens. 20° 35' 48" N, 105° 13' 52" W. Fabio Cupul, 5 August 2005. CNMO 1656. MORELOS, Municipio Emiliano Zapata, Tetecalita, 16.5 km S, 6.5 km E Cuernavaca City on the road Cuernavaca – Yautepec – Jojutla. Under rocks in cattle land. Antonio Figueroa. 9 November 1994. CNMO 553. MORELOS, 25 km N, 4 km of W Huamantla, CEAMISH Station. F.A. Noguera. 21 March 1997. CNMO 556. OAXACA, ca. 4 km NW of Tapanatepec. Road Tehuantepec-Tuxtla Gutiérrez. 16° 23' 53.9" N, 94° 12' 53.37" W. In sewage tunnel. O.J. Polaco, A.F. Guzmán, C. López and E. Naranjo. 20 August 1990. CNMO 063. QUERETARO, Jalpan, unbuilt lot at side of sidewalk about ½ a block from Hotel "Económico"

on the road Jalpan – Xilitla. E. Naranjo. 16 September 2005. CNMO 1762. SAN LUIS POTOSÍ, Cascada de Tamasopo, ca. 4 km W by dirt road from Tamasopo town, 21° 56' 05"N, 99° 25' 00"W. E. Naranjo. 7 July 1997. CNMO 641. SINALOA, Mazatlán. Plant nursery of Sr. Juan Ramírez, Av. Ejército Mexicano about 2 blocks from Calle Chachalacas. E. Naranjo. 26 July 2006. CNMO 1763. VERACRUZ, Cuitláhuac, ca. 6 km by road from Cuitláhuac town on dirt road from Cuitláhuac to Salaseca Cave. Among decaying banana leaves at banana plantation. M.T. Olivera, E. Naranjo, C. López and A.F. Guzmán. 21 August 1991. CNMO 561.

Other additions to the Veronicellidae fauna of Mexico. There are two unidentified Veronicellidae juveniles from Tuxtla Gutiérrez (México, Chiapas, Tuxtla Gutiérrez, house garden 16° 44' 44" N, 93° 04' 49" W. Javier Avendaño Gil collector, 23 October 2002, Paleontology collection, Museo de Paleontología, Instituto de Historia Natural y Ecología, Tuxtla Gutiérrez, Chiapas) and two more from near Ocozocoautla (CASIZ 079316, 32 km N of Ocozocoautla, on road to Mal Paso; 2500 feet of elevation,

Dennis E. Breedlove collector, 6 October 1974) that seem to belong to genera different from those identified so far. We think that these two veronicellids may have been introduced into the country and need more specimens to clarify the issue.

General remarks

The five species of Veronicellidae recorded from Mexico are distributed mostly from below 24° N latitude southwards to the Yucatán Peninsula (15° N) (Fig. 1).

Leidyula moreleti and *Sarasinula plebeia* are distributed mainly around the Gulf of Mexico. *Leidyula moreleti* is more widely spread in Mexico than the other species, and was recorded in the states of Campeche, Chiapas, Nayarit, San Luis Potosí, Veracruz, Oaxaca, Tabasco, and Yucatán. The record of *Leidyula moreleti* by Baker (1925) from Nayarit seems to be out of range, being the north-westernmost record of this species. It needs to be confirmed. *Sarasinula plebeia* is recorded from the states of San Luis Potosí, Veracruz and Yucatán, on the Gulf of

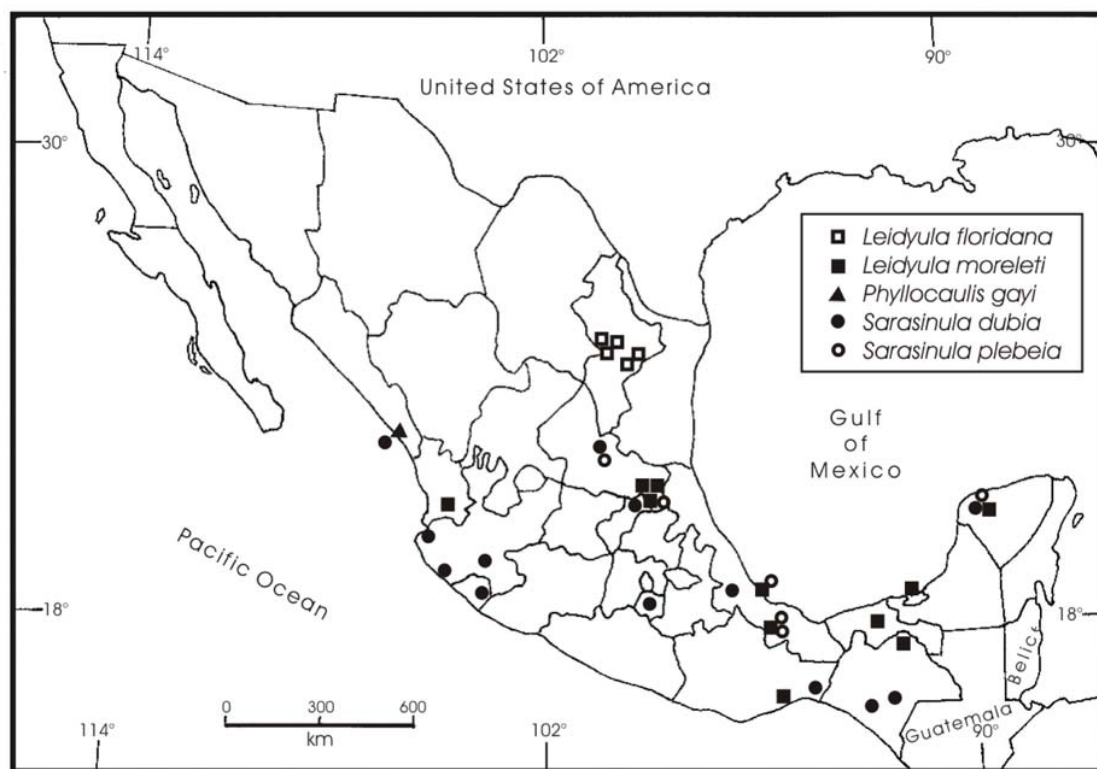


Fig. 1. Map of México showing the distribution of the five species of Veronicellidae reported from the country. Data collated from the literature and from specimens deposited in the CNMO.

Table 2. Species of Veronicellidae found in Mexico from records of specimens deposited in the CNMO, UNAM, Instituto de Biología.

State	Locality	Lm	Sd	Sp
Chiapas	1 km E Finca Custepec		X	
	5 km W cañada Teopisca		X	
Colima	Callejones		X	
Jalisco	El Grullo		X	
	Pueblo Careyes		X	
	Puerto Vallarta		X	
Morelos	Tetecalita		X	
	25 km N, 4 km W Huamantla		X	
Oaxaca	4 km NW Tapanatepec		X	
Querétaro	Jalpan		X	
San Luis Potosí	Cascada Tamasopo		X	
	Pueblo Tamasopo			X
Sinaloa	Mazatlán		X	
Veracruz	L.Tuxtlas Biological Sta.	X		X
	Cooperativa Cintepec			X
	Vivero Platino			X
	Cuitláhuac		X	
Yucatán	X'matkuil	X		
	Mérida			X

Symbols: Lm = *Leidyula moreleti*, Sd = *Sarasinula dubia*, Sp = *Sarasinula plebeia*.

México slope.

Sarasinula dubia is the second most widely distributed slug of the family. It has been found mainly in the southern half of Mexico in the states of Colima, Chiapas, Jalisco, Morelos, Oaxaca, Nayarit, Querétaro, San Luis Potosí, Veracruz, and Yucatán, along the Gulf and Pacific sides of the country. The northernmost record lies in the mid portion of the state of San Luis Potosí and the southernmost in Chiapas.

Twenty three genera of Veronicellidae have been described worldwide, and occur in the Americas, Asia, Australia, and Africa (Grimpe and Hoffmann, 1925a, b; Hoffmann, 1925; Forcart, 1953, 1963, 1967; Thomé, 1975a, b; Gomes and Thomé, 2004). North America (United States and Mexico) has 1 native genus (*Leidyula*), Central America 3, while the number of genera in South America reaches 14 (Table 2). It is uncertain whether or not the genus *Leidyula* in Mexico is represented by two native species (*Leidyula moreleti* and *Leidyula floridana*), since records of the late 1800s referred only to *L. moreleti*

(Fischer and Crosse, 1870-1878; Martens, 1890 –1901, Baker, 1923). Thomé (1993) has recorded 18 genera and a total of 43 species of Veronicellidae in the Americas; however, further studies will possibly show that fewer species exist in this region (Table 2).

In Mexico, the Veronicellidae are found from sea level to an altitude of approximately 1200 m. The mean annual precipitation of these localities ranges from 700 to 5000 mm (Garcia, 1988). Even though localities where slugs have been found lie within different types of vegetation, viz. tropical deciduous forest, tropical sub-deciduous forest, tropical rain forest and cloud forest (Rzedowski, 1983), most of our records of veronicellids in Mexico are associated with environments disturbed by man as noticed previously by Baker (1925). In studies that lasted four years in the tropical rain forest at Los Tuxtlas Biological Station (Veracruz State) Naranjo-García (1997) found no Veronicellidae in pristine forest but, in contrast, we noted them to be abundant in the garden of the same station (a managed and disturbed habitat), especially at night. Similar observations were made at the Chamela Biological Station (state of Jalisco) in western Mexico where Naranjo-García sampled regularly. There too the Veronicellidae were not living in the forest but in disturbed habitats like gardens. Such evidence suggests that human agency has been responsible for moving both the native *Leidyula moreleti* and the non-native *Sarasinula dubia* and *S. plebeia* within the country.

It is hard to explain how *Sarasinula plebeia*, described from New Caledonia (Fischer and Crosse, 1870-1878), and *Sarasinula dubia*, native to St. Thomas (Baker, 1925), reached Mexico. Nonetheless, they are a nuisance to farmers that will require creative measures to control the pest, technical assistance will be needed each time the slug population grows out of control.

Early records combined with the observed increasing species diversity of Veronicellidae slugs in the Americas southwards from the United States, through Mexico to South America, and more recent records from this country, suggest that the only native veronicellid in Mexico is *Leidyula moreleti*. Three species *Phyllocaulis gayi*, *Sarasinula dubia* and *S. plebeia*, are considered non native. This hypothesis is supported by the lack of findings of slugs outside pristine forests around human habitation, especially in city and suburban gardens, nurseries and rubbish tips. The presence of *Leidyula floridana* and *Phyllocaulis gayi* needs confirmation.

Acknowledgements

We thank Larry Currie from the California Academy of Sciences; Felipe Villegas and Fernando Chiang-

Cabrera from Instituto de Biología, Universidad Nacional Autónoma de México; Oscar J. Polaco from Instituto Nacional de Antropología e Historia; Alberto Contreras-Arquieta from Pronatura and Christopher C. Appleton from the University of KwaZulu-Natal, South Africa, who helped in various ways. DGAPA-UNAM provided a grant to ENG as Visiting Scholar at Instituto de Biociencias-PUCRS, Porto Alegre, Rio Grande do Sul, Brazil.

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