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Scientific Note

New Findings of Freshwater Halacarid mites (Acari: Halacaridae) in Mexico

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Abstract. Freshwater Halacaridae are poorly known in Mexico. The only species reported so far is *Limnohalacarus cultellatus* Viets, 1940 from Quintana Roo, but the country is still a white spot for this group of mites. Recently, some halacarid specimens were collected in samples from two locations in Mexico City. Herein we present the records of two species: *Porolohmanella violacea* (Kramer, 1879), and *Porohalacarus alpinus* (Thor, 1910), which increase the number of epicontinental halacarids to three. These records are the first for the country and extend the known worldwide distribution range for each of these species. Future studies will certainly increase the number of halacarid species, and probably the percentage of species of these aquatic mites in Mexico.

Keywords: New record, water mites, distribution range, *Porolohmanella*, *Porohalacarus.*

Mites of the suborder Prostigmata constitute a heterogeneous group for their morphology, biology and behavior. The superfamily Halacaroidea inhabits aquatic environments, both freshwater and marine. They are small, inconspicuous mites, without a bright coloration like the Hydrachnidiae and with a different degree of sclerotization. Halacaridae have at least 1,118 described species around the world (Zhang et al. 2011). They are predominantly marine, but amongst them, more than 60 species in less than 20 genera are specialized for life in epicontinental and coastal fresh and oligohaline brackish water habitats (Bartsch 2009).

Records of Halacaridae for the American continent are scarce. Ten species of eight freshwater halacarid genera and three limnic species of three marine genera are known from North America (Bartsch 2011). For Mexico, halacarid mites are represented by nine species: *Agaue variabilis* MacQuitty, 1984, *Agauopsis filirostris* MacQuitty, 1983, *Copidognathus ilsebartschi* MacQuitty, 1984, *Halacarus newelli* MacQuitty, 1984, *Simognathus cramerae* Rivas, 2006, *Actacarus giganteus* Krantz, 1971, *Copidognathus yucatanensis* Chatterjee & De Troch, 2001, and *Copidognathus unicustatus* Bartsch, 1984. A single freshwater species has been recorded, namely *Limnohalacarus cultellatus* (Viets, 1940) from a sinkhole "cenote Bang" near Tulúm, Quintana Roo (Ojeda et al. 2016). Although the specific geographical position of Mexico in the continent (land-bridge connections to South America during the past), the halacarid mite fauna of the country is still poorly known, when compared with European countries (Bartsch 2008). South American records of the group were presented recently by Pepato & Conceição (2020); mentioning nine species of five genera (*Lobohalacarus* Viets, 1939 - three species, *Peregrinacarus* Bartsch, 1999 one species, *Soldanellonyx* two species, *Limnohalacarus* Walter, 1917 two species, and *Porohalacarus* Thor, 1922 one species) of five countries (Argentina, Brazil, Chile, Peru and Venezuela).

To contribute to the knowledge of this group of aquatic mites, we recently visited some locations in central Mexico where some halacarid specimens were collected from lentic freshwater habitats.

Herein we present the first records of two species for Mexico: *Porolohmanella violacea* (Kramer, 1879) and *Porohalacarus alpinus* (Thor, 1910). The records presented here extended the distribution range worldwide for each one of these species.

Specimens were collected by washing algae and another type of aquatic vegetation from rocky shores through a 0.1 mm sieve, in the Cantera Oriente, Reserva Ecológica del Pedregal de San Ángel (REPSA), Ciudad de México (CDMX); and the Magdalena River, La Magdalena Contreras, CDMX. (Fig. 1). Mites were sorted under a stereoscopic microscope and fixed in 70% alcohol, cleared in lactic acid and mounted in Hoyer's medium. Microphotographs were obtained with an AxioCam MRC5 camera using a Carl Zeiss AxioZoom V16 microscope. The specimens were collected under the scientific collector's license (FAUT-0230) by the Mexican environmental authority (SEMARNAT). Most of the material is kept in the collection of the first author and some vouchers are deposited in Colección Nacional de Ácaros (CNAC), Instituto de Biología, UNAM.

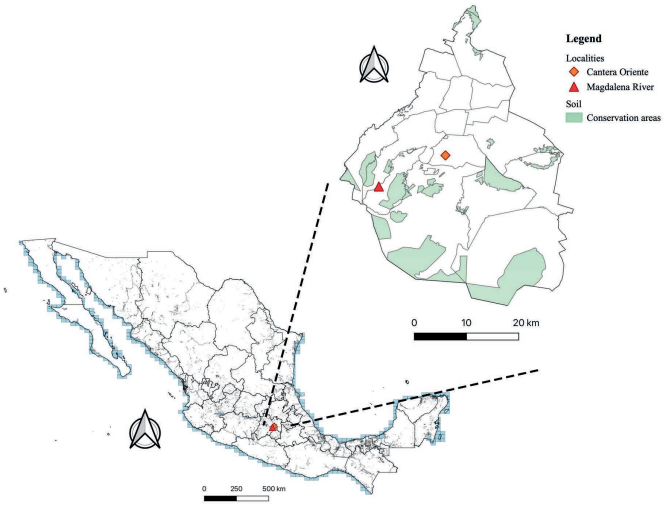

Figure 1. Map showing the locations in Mexico City where Halacaridae species were found.

The abbreviations used are as follows: AD, anterior dorsal plate; AE, anterior epimeral plate; ds, dorsal setae on idiosoma, from anterior to posterior: ds-1 to ds-5; GA, genitoanal plate; GO, genital opening; gac, genital acetabula; gp, dorsal or lateral gland pores, from anterior to posterior: glp-1 to glp-5; OC, ocular plate; pc, pore canaliculi; PD, posterior dorsal plate; PE, posterior epimeral plate; pgs, perigenital

setae; sgs, subgenital setae; legs numbered I to IV and the segments, from distal to proximal, are as follows: Tarsus, tibia, genu, telofemur, basifemur and trochanter; palpal segments are in the same order, numbered P-4 to P-1. Measurements are given as micrometers (µm).

The taxonomic position follows Krantz & Walter (2009) and is outlined below:

Subclass Acari
Order Trombidiformes
Suborder Prostigmata
Supercohort Eupodides
Superfamily Halacaroidea
Family Halacaridae

***Porohalacarus alpinus* (Thor, 1910)**

(Figs. 2A-D)

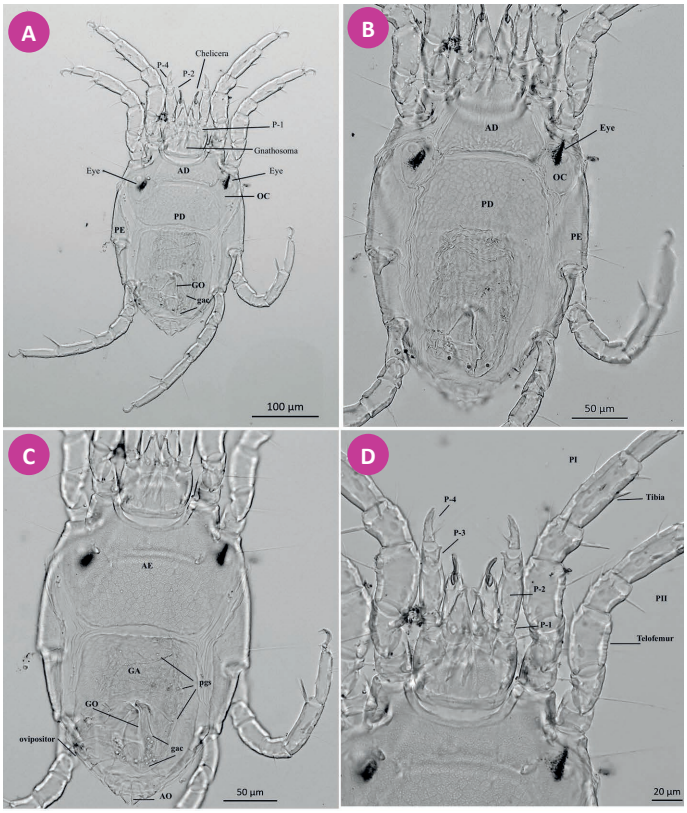

Figure 2. *Porohalacarus alpinus* (Thor, 1910). A. Habitus; B. Dorsal plates showing the ornamentation; C. Ventral view, genital acetabula; D. Detail of the anterior half of the mite.

Diagnosis - Female. Idiosoma rather slender, length range 326-384 µm (358). Dorsal plates with longitudinal reticulation (Figs. 2A, 2B). With three black eye spots, one unpaired spot beneath the anterior plate and one each beneath cornea of ocular plates. Acetabula on genital sclerites; each sclerite with five to seven such acetabula, some with asymmetry left or right (5-6 or 6-7) (Fig. 2C). Gnathosoma length/width ratio 1.2. Palps lateral, extending beyond short, triangular rostrum. Second palpal segment with two setae (Fig. 2D); third segment with short spine. Legs I and II are similar in shape. Genu I with a pair of setae. Tibiae I and II with four and three short ventral setae, respectively. Tibiae III and IV each with a pair of pectinate ventral setae and a pectinate medial seta. Claws of all tarsi with delicate tines. *Porohalacarus alpinus* is easily identified because of its black eye spots.

Distribution - *Porohalacarus alpinus* is worldwide present, except in Antarctica. In the American continent it has been registered in North America: Canada: in the provinces of Ontario and Quebec. United States: New Hampshire and Rhode Island States (Bartsch 2011), and South America: Brazil: Rio Grande do Sul, Imbé (Pepato & Conceição 2020).

Material - New Record. Mexico, Mexico City, oligotrophic pond at Cantera Oriente, Reserva Ecológica del Pedregal de San Ángel (REPSA), 19°19'15'' N 99°10'22'' W, 2286 m asl, stones and vegetation, 03.11.2015 (10 specimens), 22.02.2016 (62), 27.04.2016 (114), 29.06.2016 (5), 30.07.2016 (41); Ojeda & Carlos colls.

Voucher material - Most of the material is kept in the Collection of the first author, three specimens (two in alcohol, and one in a semi permanent slide) are deposited in the Colección Nacional de Ácaros (CNAC), Instituto de Biología, UNAM, with catalog numbers (CNAC-012403-012405).

Remarks - The specimens were collected in the REPSA abundantly (232 specimens) at different times during a year period (2015-2016). February and April were the months with more specimens. We found larvae, nymphs and females, but among all the material no males were observed. The morphological characteristics and idiosoma size and other body-size proportion of our specimens are consistent with what is described for the species. However, we observed some asymmetries in the number of acetabula, with specimens bearing six or seven, on left/right. The specimens were observed in association with *Porolohmanella violacea* and the oribatid *Hydrozetes lemnae* (Coggi, 1897) (168 specimens of both adults and nymphs), as well as with some Hydrachnidiae of the families Limnesiidae (*Limnesia* sp., 20 specimens), Sperchontidae (*Sperchon* sp., 13), Arrenuridae (*Arrenurus* sp., 3), and several larvae (41).

***Porolohmanella violacea* (Kramer, 1879)**

(Figs. 3A-D)

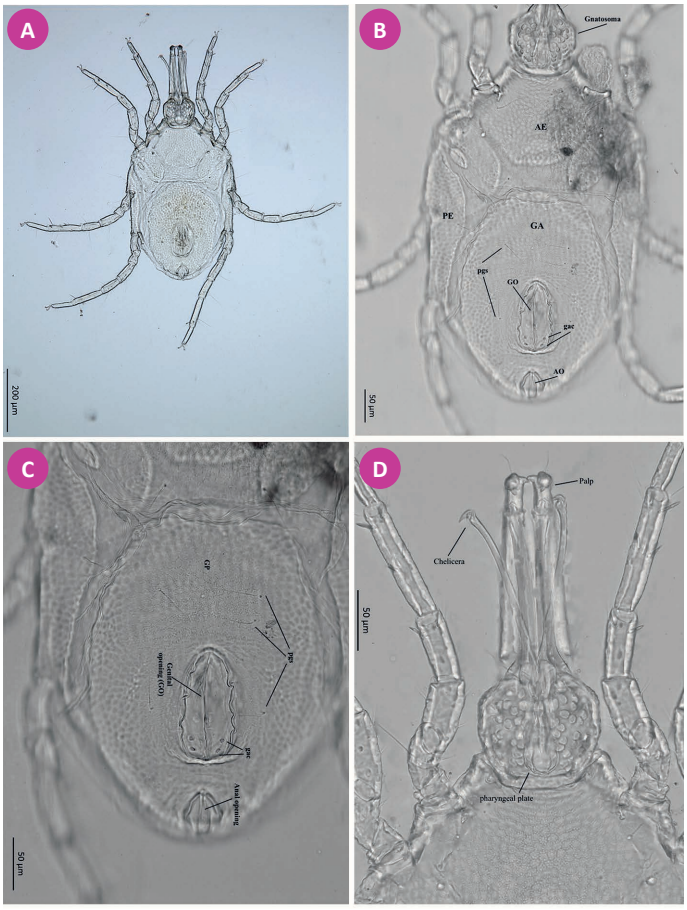

Figure 3. *Porolohmanella violacea* (Kramer, 1879). A. Habitus; B. Dorsal view, plates and reticulation pattern; C. Ventral view; D. Gnathosoma.

Diagnosis - Female. Idiosoma flattened, and some purple-pink color, female length 503 µm. Idiosomal plates delicately reticulated (Figs. 3A, 3B). Small eye spots (cornea) present beneath the anterior dorsal plate and ocular plates. AE 175 , GA 309, PE 241, AD 160, PD 323. Gnathosoma slender, almost half length of idiosoma 306 µm (Fig. 3D). Ratio of gnathosoma to idiosoma 0.62. Rostrum slender, parallel-sided. Palps slender, dorsal (proximal segment hidden by rostrum when observed from venter). Second segment with a single seta. Gnathosoma base with well-developed foveolae. GP with six pgs and no sgs. Each genital sclerite with two acetabula (Fig. 3C). Legs slender; legs I and II similar in size. Tibiae I with 3-5 ventral setae, tibiae II and III with 3-4, and tibiae IV with 2-4 setae. Tarsi with small claws (Fig. 3A).

Distribution - *Porolohmanella* is considered a monotypic genus

(Abé 2021). The species inhabits freshwater and rarely brackishwater and is widely distributed in the Holarctic region except for Antarctica. In the American continent it has been registered in Canada: Alberta, British Columbia, Vancouver Island, Manitoba, Newfoundland, Ontario, and Quebec. United States: New Hampshire, New York, and Rhode Island (Bartsch 2011; Abé 2021).

Material - New Record. Mexico: Mexico City, oligotrophic pond at Cantera Oriente, Reserva Ecológica del Pedregal de San Ángel (REPSA), 19°19'15'' N 99°10'22'' W; 2,286 m asl; stones and vegetation, 03.11.2015 (2 specimens), 27.04.2016 (3), 29.06.2016 (2), 30.07.2016 (2) Ojeda & Carlos colls.; Mexico City, Magdalena Contreras, Magdalena River, 2do. Dinamo, 19°20'00'' N 99°12'50'' W; 2,503 m asl, vegetation, 08.2017 (1 deutonymph), K. Hernández colls.

Voucher material - Most of the material is kept in the Collection of the first author. One specimen is in the Colección Nacional de Ácaros (CNAC), Instituto de Biología, UNAM, with catalog number (CNAC-012406).

Remarks - *Porolohmanella* is a monotypic genus, the main distinctive characteristic among other freshwater halacarids is its long, slender gnathosoma, almost half length of idiosoma as well as the purple-pink coloration. Males are unknown.

Habitat - This species is found associated with mosses, algae and dendritic sediments, in ponds, swamp and lakes. *P. violacea* has also been found amongst the gills of freshwater crayfish (Bartsch 2011). Some reports mentioned them in stony and rocky bottoms at a depth of 0-40 m and altitudes between 0-1,810 m (Abé 2021).

The specimens were obtained in small numbers from the REPSA at different times of the year, whereas *Porohalacarus alpinus* was well represented. During the time of the study P. *violacea* was found in association with the oribatid *Hydrozetes lemnae,* as well as with members of the taxon Hydrachnidiae (*Limnesia* sp., *Sperchon* sp., *Arrenurus* sp.).

According to published records (including present report), 14 named species of freshwater Halacaridae belonging to 9 genera have been identified in the American continent. *Soldanellonyx* Viets, 1939 is the one with more species (4), followed by *Lobohalacarus* Walter, 1917 (3) and *Limnohalacarus* (2), the remaining genera with a single species (Bartsch 2009; 2011; Abé 2020; Pepato & Conceição 2020). *Porolohmanella violacea* has reports from northern North America and Canada; the record of the present study is the southernmost in the continent.

Porohalacarus alpinus is a species that could be found in various microhabitats, such as lakes, ponds, debris of vascular plants, and streams. Reports in the continent are widespread along North America with just a very few in South America and now this record for Mexico, where we collect *bona fide* records over a period of seasons. In all the samples we did not find males, probably because this species is parthenogenetic as well as has been stated for other freshwater Halacaridae (*P. violacea*) (Bartsch 2007). With these two new records, the known species of Halacaridae are updated from nine to eleven species for the country; and specifically, from one to three for the epicontinental species.

In general, it has been stated that halacarid mites have a very low dispersal ability, without dispersive or resting stages and most of all have a low rate of fecundity. Nonetheless, many genera and even species have a worldwide distribution. Halacaridae can be found associated with a wide range of conditions and are known as being generalists with immense ecological tolerance to different microhabitats and can survive short-term in deteriorating conditions. Regarding its way of dispersion, it has been pointed out that could be via slow migration both along epigean and hypogean passages, by extreme floods and storms, as well as by other animals, such as insects, birds, mammals and, even scattered by human action (Bartsch 2008). Future studies will certainly increase the number of halacarid species, and probably the percentage of species of these aquatic mites in Mexico.

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Authors' Contributions

MO collected and prepared the studied specimens, AHM collected at REPSA. MO and AHM wrote, edited and approved the final version of the manuscript. MO took photographs and prepared the figure sheets. AHM drew the map.

Conflict of Interest Statement

The authors declare that they have no conflict of interest in the publication of this article.

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