

Article

Tardigrades (Tardigrada) of Colombia: Historical Overview, Distribution, New Records, and an Updated Taxonomic Checklist

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Abstract: Tardigrades, with over 1450 species, are important organisms in ecological understanding and are valuable biological models (e.g., due to their extremotolerant capabilities). While their biodiversity is better known in Europe and North America, Central and South America have only recently started making significant contributions. Through a comprehensive review of scientific literature, biological collections, web portal consultations, and the addition of new records, this study clarifies the current knowledge of tardigrade biodiversity in Colombia. Past research started in the early 20th century, but most data are unreliable due to information gaps and the absence of specimens in biological collections. The last decade has witnessed a resurgence in tardigrade research in Colombia, leading to new species descriptions and a more robust understanding of their biodiversity. Nevertheless, the majority of the territory remains unexplored. A total of 43 known species from our analysis are present in Colombia: 26 records accepted by the literature and 17 questioned in the literature but representing distinct taxa surely present in Colombia. Other species records are considered doubtful. Our study recommends considering mostly scientific records based on verifiable material deposited in scientific collections (highlighting their importance in studying and safeguarding biodiversity) and encourages future researchers to contribute while adhering to legal requirements.

Keywords: biodiversity; geographic distribution; Neotropics; South America; water bears



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1. Introduction

Tardigrades, commonly referred to as water bears or moss piglets, represent a phylum of microscopic ecdysozoans encompassing approximately 1450 described species [1–3]. These resilient organisms are basically aquatic, inhabiting in a wide range of environments including oceans, rainforests, high mountains, and even urban areas. Remarkably, most of the known species are intricately associated with the moisture retained by lichens, liverworts, and mosses [4,5].

Water bears exhibit a notable capability to undergo a reversible metabolic shutdown, enabling survival in extreme conditions, known as cryptobiosis. They have been observed to withstand a variety of environmental stresses, such as desiccation, freezing, high pressure, exposure to radiation, and even the vacuum of space [6,7]. Consequently, tardigrades have gained substantial attention in the scientific community, emerging as model organisms across diverse research areas, specifically, in astrobiology, where they define the boundaries

of life [8]; astronautics, involving the study of their leg features for space-based tribological and adhesion purposes [9]; biotechnology, examining their DNA protection mechanisms against radiation for potential application in human cell cultures [10]; and advancements in preserving and stabilizing biological materials [11,12], including desiccation-related phenomena in mammalian cells [13]. Additionally, tardigrades contribute significantly to ecosystem services, for instance, serving as predators of plant parasitic nematodes, leading to substantial reductions in their biomass within the soil [14].

The progress in applied research and the understanding of ecological aspects of tardigrades requires, first and foremost, a deep knowledge of their biodiversity. However, the study of tardigrades represents a challenge due to their small size, which makes them difficult to locate and handle. Taxonomic studies of these organisms based on morphology and morphometry require significant dedication and specialized microscopy (phase contrast microscopy—PCM, differential interference contrast microscopy—DIC, and scanning electron microscopy—SEM). Furthermore, the preparation and mounting of tardigrades for identification require a certain level of expertise, as individuals must be positioned precisely to provide sufficient diagnostic information.

The biodiversity of tardigrades in Europe and North America has been extensively studied; however, only in recent decades, has knowledge aimed at filling the information gap on tardigrades begun to be generated in Central and South America. Several studies have been conducted, including McInnes' [15] zoogeographic distribution of terrestrial/freshwater tardigrades, and a monograph by Meyer [16] that provides a comprehensive list of the terrestrial and freshwater tardigrade fauna of North, Central, and South America, as well as the West Indies (Antilles and Bahamas). Additionally, a series of scientific papers have provided information on the biogeography of non-marine tardigrades from the Americas [17–19]. Some studies have been also conducted in most South American countries including Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Surinam, Uruguay, and Venezuela [20]. Although about 260 species have been recorded, contributing significantly to our understanding of the tardigrade fauna in America, there is still much work to be done.

Recording the biodiversity of tardigrades in Colombia began during the first half of the 20th century [21–23]. Despite this early start, there have been significant gaps in information generation over extensive periods of time. Additionally, the initial species identifications were made using taxonomic criteria of the time (today, considered poorly reliable), the illustrations do not provide sufficient details, there are no photographic records, precise information regarding specific collection localities is lacking, the whereabouts of the collected material are unknown, and the described species have insufficient information and lack the type material support. This renders a significant portion of this information unverifiable and consequently casts doubt on many records and descriptions. The last decade, however, has seen a surge in research activity, resulting in notable contributions to our understanding of tardigrade biodiversity. Despite these advances, vast areas of Colombian territory remain unexplored, highlighting the need for continued research efforts.

Through a thorough reconstruction of the history of tardigrade biodiversity research in the country, the primary objective of this research is to provide a comprehensive and up-to-date account of the tardigrade fauna in Colombia, including new records and data on the geographic distribution of species, some taxonomic remarks, and the development of an updated checklist of valid tardigrade species for the country.

2. Materials and Methods

2.1. Historical Reconstruction, Distribution of Tardigrades, and Development of an Updated Checklist

The history of tardigrade research in Colombia was reconstructed based on a bibliographic review of taxonomic papers published between 1911 and 2023, documenting tardigrade species in Colombia. The recorded species from these investigations were compared with the periodically updated tardigrade species checklist maintained by Guidetti

and Bertolani [1] and Degma and Guidetti [2,3]. The validity of each taxon and record was verified in the scientific literature, and the nomenclature was updated in accordance with the latest taxonomy within the phylum. When possible, the existence of type material or collection material, supporting the description of new species and records, respectively, was confirmed. Additionally, inquiries were made at various research institutions and universities regarding the presence of researchers, research groups, and/or biological collections of tardigrades. Biodiversity datasets from the Sistema de Información sobre Biodiversidad de Colombia (SiB Colombia) and the Global Biodiversity Information Facility (GBIF) web portals were also reviewed and validated. An updated checklist of species was compiled, incorporating new records based on material collected in 2022 from the departments of Atlántico, Bolívar, and Sucre; specimens collected in 2018 from the department of Antioquia; and a revision of specimens from the department of Magdalena deposited in the Centro de Colecciones Científicas de la Universidad del Magdalena (CCC), subsection Colecciones Biológicas de la Universidad del Magdalena (CBUMAG). A map illustrating the georeferenced locations of tardigrade records in Colombia, which were cataloged in collections and documented in the scientific literature, was developed. When coordinates were not provided, the collection sites were georeferenced in Google Earth. The coordinates were standardized through the Universal Transverse Mercator (U.T.M.) system using the online tool available at <https://data.canadensys.net/tools/coordinates> (20 November 2023), with consideration given to the MAGNA-SIRGAS Datum. Furthermore, an additional map was created to showcase the various departments along with the respective counts of recorded species. All of these procedures were carried out using the QGIS software (version 3.34.1).

2.2. Exploration of Novel Tardigrade Records

In the departments of Bolívar, Atlántico, and Sucre, tardigrades were found in samples of epiphytic lichens and mosses at various locations: Santuario de Flora y Fauna Los Colorados (Bolívar), Reserva Campesina “La Montaña” (Atlántico), Reserva Natural Luriza (Atlántico), and Reserva de la Sociedad Civil “Caracolí” (Sucre). All of these locations are part of the research project “Water bears (Tardigrada) associated with bryophytes and lichens in fragments of tropical dry forest of Los Montes de María and La Serranía de Piojó. A contribution to the biodiversity of Colombia,” and were selected for reasons of accessibility and the presence of microhabitats. In the department of Antioquia, specimens were retrieved from dried moss samples collected at the campus of Universidad de Antioquia as part of the Master degree project “Tardigrade of the city of Medellín, Colombia”. After rehydration for 24 h and filtration through 2.5 mm and 38 µm sieves, the fractions of the samples retained by the second sieve were examined with a Carl Zeiss Model STEMI 305 binocular stereoscope (Oberkochen, Germany). Micropipettes (5 to 50 µL) were used to extract specimens and eggs. The permanent mounts were prepared with Polyvinyl Alcohol (PVA) mounting medium (BioQuip Products Inc. Compton, CA, USA). Tardigrade identification was based on morphological and morphometric characteristics using Zeiss Axiolab A5 Phase Contrast Microscope and Zeiss Axio Scope A1 differential interference contrast microscope (Oberkochen, Germany). The specimens from Bolívar, Atlántico, and Sucre were deposited in the CCC (Registro Nacional de Colecciones RNC: 207), and those from Antioquia were deposited in the Colección Limnológica Universidad de Antioquia (CLUA035).

Species were identified based on original descriptions and diagnoses [24–36]. Morphometry was performed with Zen 3.5 (blue edition) software, and data were analyzed using templates from the Tardigrada Register [37] (www.tardigrada.net/register (14 February 2023)).

3. Results

3.1. History

The first documented records of tardigrades in Colombia date back to the second and third decades of the 1900s, when the German zoologist Ferdinand Richters and Swiss bryologist Fritz Heinis conducted their research (Figure 1). During this time, the species *Hypsibius fuhrmanni* (Heinis, 1914) was described [23], while 26 others were recorded (Table 1). These findings were based on materials (mosses and lichens) collected and sent to those researchers by colleagues whose primary focus was not the study of tardigrade fauna [21–23,38]. In 1936, Marcus published his monograph on tardigrades [39], in which he compiled information about the species documented by Richters and Heinis, and provided a higher taxonomic resolution, identifying two species that had only been reported by these authors as genera [40]. However, it is essential to note that all of these earlier records, including the species *H. fuhrmanni*, have since been invalidated or questioned ([18,35,40–43], this paper) due mainly to the following reasons: (1) specimens lacking georeferencing data; the localities were imprecise, and sometimes only the department in which they were found was mentioned in a general manner. (2) There is no evidence of the existence of type material or specimens in collections, and the descriptions were highly generalized and lacking the morphometric information required for identification verification. (3) Several records were assigned to species (e.g., *Macrobiotus hufelandi* C.A.S. Schultze, 1834; *Milnesium tardigradum* Doyère, 1840) that have since been re-evaluated and divided into numerous taxa, which, today, constitute species complexes, and unfortunately, there is no photographic evidence or detailed illustrations and descriptions available that would facilitate their reassignment.

After the initial studies, there was an approximately six-decade gap in tardigrade research in Colombia (Figure 1). The term “Tardigrada” re-emerged in the Colombian scientific literature in 1994 in a publication focusing on paramo ecosystems in the Western Cordillera of Colombia. Regrettably, the material used in that study was not preserved, and no additional information beyond the number of specimens found was provided [44]. It was not until Jerez and Narvaez [45] and Jerez et al. [46] conducted an inventory of tardigrades in the Reserva Natural “El Diviso”, located in the department of Santander, that a more comprehensive study was undertaken (Figure 1). They recorded 15 species of tardigrades, and the specimens were supposed to be housed in the Museo de Ciencias Naturales at the Universidad Nacional; however, it appears that they were never cataloged, and their current whereabouts are unknown. Nonetheless, some species have been subsequently recorded in the country in different regions (i.e., *Minibiotus intermedius* (Plate, 1888)), but the absence of collection material prevents the confirmation of these records. For this reason, most records from these publications have been cast into doubt ([18,40], this paper) (Table 1).

Additionally, some reports that may or may not contain material deposited in scientific collections have also been questioned for not providing sufficient taxonomic resolution, primarily due to the absence of eggs for species identification (i.e., *Macrobiotus* sp. [23]; *Paramacrobiotus richtersi* (Murray, 1911) [45]; *Calcarobiotus* sp., *Macrobiotus* sp. 1 *hufelandi* group, *Macrobiotus* sp. 2 *hufelandi* group, *Paramacrobiotus areolatus* group, and *Paramacrobiotus richtersi* [47]; *Macrobiotus* sp. 1, *Macrobiotus* sp. 2, *Mesobiotus* sp., formerly reported as *Macrobiotus* sp. 3, *Minibiotus* cf. *pilatus* (Claxton, 1998), and *Minibiotus* sp. [48]; *Macrobiotus* cf. *hufelandi* [40]) (Table 1).

More specifically, in the current investigation, the following records have come under scrutiny (Table 1) for the following reasons.

Barbaria bigranulata (Richters, 1907), initially documented as *Echiniscus bigranulatus* for Cundinamarca [38], has been cast into doubt by Melo et al. [40]. This skepticism arises from the observation that all pre-2006 records necessitate reassessment due to their classification within the *bigranulatus* group, a taxonomic category prone to potential confusion with other members. However, Melo et al. [40] formally establish the presence of this species in the

Guatavita lagoon in Cundinamarca, contending that these specimens align precisely with the redescrptions undertaken by Michalczyk & Kaczmarek [49] (Table 2).

The validity of the species *Echiniscus fischeri* Richters, 1911 has been refuted by Rocha et al. [50] owing to the absence of type material. Consequently, the record of this species for Antioquia [23] is also subject to scrutiny in the context of this investigation.

The record of *Echiniscus* sp. for Tolima [23] has been reclassified by Marcus [39] as *Pseudechiniscus* sp. Nevertheless, insufficient characteristics described in the record and the absence of collection material prevent the determination of the species.

After reviewing the collection material from the *Echiniscus* sp. record for Magdalena [47], which consists of a single specimen, it was reclassified as the species *Bryodelphax kristenseni* Lisi, Daza, Londoño & Quiroga, 2017. This species was described based on the type material collected in the same department.

The record of *Echiniscus* sp. for Bogotá [23] was reattributed to *Pseudechiniscus brevimontanus* Kendall-Fite & Nelson, 1996 by Meyer [16]. However, it is a species susceptible to confusion with other *Pseudechiniscus* species documented in Colombia. Regrettably, the absence of collection material along with incomplete details in the description and drawings of the record do not allow definitive confirmation or reassignment. Consequently, it remains doubtful in this work.

The taxon *Pseudechiniscus novaezeelandiae aspinosa* Iharos, 1963 is classified as a *nomen dubium* by Tumanov [51], suggesting it to be an entirely novel entity (“yet undescribed species of the genus *Pseudechiniscus*” [51]). Consequently, the record of this taxon for Magdalena is questionable. However, its distinguishing characteristics set it apart from other species within the genus. Despite the uncertain status of the recorded species, it is recognized as a distinct taxon present in Colombia (Table 3) and merits a more comprehensive investigation. Although the collection material has been examined, a definitive determination regarding its accurate identity remains elusive.

The records of *Milnesium* sp. [47,48], despite having collection material, require meticulous examination to distinguish these records as distinct entities from each other and from other species within the genus reported in Colombia.

Diphascon chilense (Plate, 1888) is categorized as a *nomen dubium* by Dastych [41], casting doubt on the record of this species in the country. Nevertheless, even in the absence of collection material, it can be regarded as a taxonomically distinguishable entity from others in the genus documented in Colombia (Tables 1 and 3).

The collection specimens of the *Diphascon higginsii* (Binda, 1971) record reported by Lisi et al. [48] for Magdalena have been reanalyzed and could be a different species. However, it has not yet been determined. The record is therefore, for the moment, considered doubtful (Table 1).

The collection material corresponding to the records for the Magdalena of *Hypsibius* cf. *allisoni* [20], as well as *Doryphoribius* sp. *evelinae* group and *Doryphiribius* sp. *vietnamensis* group [47], requires a more thorough review for complete determination. These taxa may be confused with other species of the same pertinent genus that have already been reported for Colombia.

The record for the Magdalena of *Diphascon* sp. *pingue* group [20], though without complete taxonomic resolution, counts as a taxonomically distinguishable entity from other species reported in Colombia (Tables 1 and 3), as well as *Diphascon pingue pingue sensu lato* recorded in the same paper [20].

The species *Milnesium barbadosense* Meyer & Hinton, 2012 needs to be redescribed as there is insufficient diagnostic information provided in its description, including doubtful morphometry due to very wide morphometric ranges for several characters, making difficult the distinction between this species and other similar ones. This is the reason for our uncertainty of the diagnosis of our records of *Milnesium* cf. *barbadosense* for the Magdalena [52]. Nevertheless, our morphotype possesses distinguishing characters from the others of the genus in the checklist and should be therefore regarded as a valid taxonomic entity present in Colombia (Tables 1 and 3).

The records of *Hypsibius* sp. and *Itaquascon* sp. for Santander made by Jerez and Narváez in 2001 [45] do not provide sufficient information, and there is no collection material to determine the species; they could belong to any other Hypsibiidae already reported for Colombia.

The documentation of *Fractonotus* sp. [20] is based on collection material of poor quality and remains undetermined due to the potential for confusion with *F. verrucosus* (Richters, 1900) or *F. caelatus* (Marcus, 1928), the former of which has already been reported in Colombia.

Ramazzottius oberhaeuseri (Doyère, 1840) was reported by Heinis [23] (as *Macrobiotus oberhaeuseri* var. *granulatus* at that time). The records have been recently questioned [18,40] and are now considered “sensu lato”, and the lack of sufficient details in the report and collection material hinders verifying the diagnosis; however, this taxon cannot be confused with any other species reported in Colombia and therefore counts as a taxonomic entity present in the country (Table 3).

Table 1. Colombian known records from the literature that are now considered doubtful. This list also includes all records for which a complete diagnosis has not been achieved. Species names with * have been adjusted to current taxonomy in the present study. Species names with ** have been invalidated. The species *Hypsibius fuhrmanni*, described from specimens collected in Colombia, is considered a *nomen dubium* due to the absence of type material. Department: ANT—Antioquia; ATL—Atlántico; BOL—Bolívar; CAU—Cauca; CES—César; CUN—Cundinamarca; DC—Bogotá Distrito Capital; MAG—Magdalena; SAN—Santander; TOL—Tolima; VAC—Valle del Cauca.

Taxa	Department	Recorded by	Invalidated or Questioned by
Tardigrada Doyère, 1840 Heterotardigrada Marcus, 1927 Echiniscoidea Richters, 1926 Echiniscidae Thulin, 1928			
* <i>Barbaria bigranulata</i> (Richters, 1907)	CUN	[38]	[40]
* <i>Claxtonia</i> cf. <i>wendti</i> (Richters, 1903)	TOL	[21]	[18,40]
<i>Echiniscus blumi blumi</i> Richters, 1903	ANT	[23]	[18,40]
** <i>Echiniscus fischeri</i> Richters, 1911	ANT	[23]	This paper
<i>Echiniscus quadrispinosus</i> Richters, 1902	ANT, CUN	[23]	[18,40]
<i>Echiniscus spiniger</i> Richters, 1904	CUN	[23]	[18,40]
<i>Echiniscus testudo</i> (Doyère, 1840)	ANT, CUN, VAC	[23,39]	[18,40]
<i>Echiniscus virginicus</i> Riggin, 1962	MAG	[48]	[34]
<i>Echiniscus</i> sp.	MAG	[47]	This paper
<i>Pseudechiniscus</i> sp.	TOL	[23,39]	This paper
<i>Pseudechiniscus brevimontanus</i> Kendall-Fite & Nelson, 1996	CUN, DC	[16,23]	This paper
<i>Pseudechiniscus novaezeelandiae</i> (Richters, 1908)	ANT, SAN, TOL	[22,23,45]	[40]
** <i>Pseudechiniscus novaezeelandiae aspinosa</i> Iharos, 1963	MAG	[47]	This paper
* <i>Pseudechiniscus suillus</i> (Ehrenberg, 1853)	ANT, CUN, SAN, VAC	[21–23]	[18,40]
Eutardigrada Richters, 1926 Apochela Schuster, Nelson, Grigarick & Christenberry, 1980 Milnesiidae Ramazzotti, 1962			
<i>Milnesium</i> cf. <i>barbadosense</i> Meyer & Hilton, 2012	ATL, BOL, CES, MAG	[52]	This paper
<i>Milnesium tardigradum</i> Doyère, 1840	SAN	[45]	[18]
<i>Milnesium tardigradum sensu lato</i> Doyère, 1840	ANT, CUN	[23]	[18,40]
<i>Milnesium</i> sp.	MAG	[47]	This paper
<i>Milnesium</i> sp.	MAG	[48]	This paper

Table 1. Cont.

Taxa	Department	Recorded by	Invalidated or Questioned by
Parachela Schuster, Nelson, Grigarick & Christenberry, 1980			
Calohypsibiidae Pilato, 1969			
* <i>Calohypsibius ornatus</i> (Richters, 1900)	CUN	[23]	[18]
Hypsibiidae Pilato, 1969			
** <i>Diphascon chilense</i> Plate, 1888	ANT, CUN, TOL	[22,23]	This paper
<i>Diphascon higginsii</i> Binda, 1971	MAG	[48]	This paper
<i>Diphascon</i> sp. <i>pingue</i> group	MAG	[20]	This paper
<i>Diphascon pingue pingue</i> sensu lato (Marcus, 1936)	MAG	[20]	This paper
<i>Hypsibius</i> sp.	SAN	[45]	This paper
<i>Hypsibius</i> cf. <i>allisoni</i> Horning, Schuster & Grigarick, 1978	MAG	[20]	This paper
<i>Hypsibius dujardini</i> (Doyère, 1840)	CUN	[40]	[18,42]
** <i>Hypsibius fuhrmanni</i> (Heinis, 1914)	ANT	[23]	[18,42]
Acutuncidae Vecchi, Tsvetkova, Stec, Ferrari, Calhim, Tumanov, 2023			
* <i>Acutuncus antarcticus</i> (Richters, 1904)	ANT	[18]	[18,40]
Itaquasconidae Bartoš {in Rudescu, 1964}			
* <i>Adropion scoticum</i> (Murray, 1905)	CUN	[23]	[18,40]
<i>Itaquascon</i> sp.	SAN	[45]	This paper
Pilatobiidae Bertolani, Guidetti, Marchioro, Altiero, Rebecchi & Cesari, 2014			
* <i>Notahypsibius arcticus</i> (Murray, 1907)	ANT, SAN	[23,45]	[18]
Doryphoribiidae Gąsiorek, Stec, Morek & Michalczyk, 2019			
<i>Doryphoribius</i> sp. <i>evelinae</i> group	MAG	[47]	This paper
<i>Doryphoribius</i> sp. <i>vietnamensis</i> group	MAG	[47]	This paper
Isohypsibiidae Sands, McInnes, Marley, Goodall-Copestake, Convey & Linse, 2008			
<i>Dianeia sattleri</i> sensu lato (Richters, 1902)	MAG	[20,48]	[18]
<i>Fractonotus</i> sp.	MAG	[20]	This paper
<i>Fractonotus verrucosus</i> (Richters, 1900)	SAN	[45]	[18,40]
<i>Isohypsibius prosostomus</i> Thulin, 1928	SAN	[45]	[18,40]
Macrobiotidae Thulin, 1928			
<i>Calcarobiotus</i> sp.	MAG	[47]	This paper
<i>Macrobiotus</i> cf. <i>occidentalis</i> Murray, 1910	SAN	[45]	[18]
<i>Macrobiotus echinogenitus</i> Richters, 1903	ANT, CUN, SAN, TOL	[22,23]	[18,40]
<i>Macrobiotus hufelandi</i> C.A.S. Schultze, 1834	ANT, SAN, TOL	[22,23,45]	[18,40]
<i>Macrobiotus</i> cf. <i>hufelandi</i> C.A.S. Schultze, 1834	CUN	[40]	This paper
<i>Macrobiotus</i> sp.	CUN	[23]	This paper
<i>Macrobiotus</i> sp. 1	MAG	[48]	This paper
<i>Macrobiotus</i> sp. 2	MAG	[48]	This paper
<i>Macrobiotus</i> sp. 1 <i>hufelandi</i> group	MAG	[47]	This paper
<i>Macrobiotus</i> sp. 2 <i>hufelandi</i> group	MAG	[47]	This paper
** <i>Macrobiotus rubens</i> Murray, 1907	TOL	[23]	[18,40,43]
<i>Mesobiotus harmsworthi</i> (Murray, 1907)	CUN, SAN	[22,45]	[18,40]
* <i>Mesobiotus</i> sp.	MAG	[48]	This paper
<i>Minibiotus intermedius</i> (Plate, 1888)	ANT, CUN, MAG, SAN, TOL	[23,45,47]	[18]
<i>Minibiotus</i> cf. <i>pilatus</i> Claxton, 1998	MAG	[48]	This paper
<i>Minibiotus</i> sp.	MAG	[48]	This paper

Table 1. Cont.

Taxa	Department	Recorded by	Invalidated or Questioned by
<i>Paramacrobotus areolatus</i> (Murray, 1907)	SAN	[45]	[18,40]
<i>Paramacrobotus richtersi</i> (Murray, 1911)	SAN	[45]	This paper
<i>Paramacrobotus areolatus</i> group	MAG	[47]	This paper
<i>Paramacrobotus richtersi</i> group	MAG	[47]	This paper
Murrayidae Guidetti, Rebecchi & Bertolani, 2000			
* <i>Murrayon pullari</i> (Murray, 1907)	ANT	[23]	[18]
Richtersiusidae Guidetti, Schill, Giovannini, Massa, Goldoni, Ebel, Förschler, Rebecchi & Cesari, 2021			
* <i>Diaforobiotus islandicus</i> (Richters, 1904)	SAN	[45]	[18]
* <i>Diaforobiotus</i> cf. <i>islandicus</i> (Richters, 1904)	CUN	[40]	This paper
* <i>Richtersius coronifer</i> (Richters, 1903)	CAU	[23]	[18,40]
Ramazzottidae Sands, McInnes, Marley, Goodall-Copestake, Convey & Linse, 2008			
<i>Ramazzottius oberhaeuseri</i> (Doyère, 1840)	ANT, CAU, TOL	[23]	[18,40]

The period between 2008 and 2023 has been the most active and arguably the most rigorous in terms of taxonomy. A total of 10 scientific articles have been published, describing 11 species from type material collected in Colombia [20,31,32,48,52–57], and 37 records have been made, all based on material that has been formally deposited and cataloged in biological collections, and also compared with the type material of the reported species [20,31,32,40,47,48,52–57] (Figure 1, and Tables 2 and 3).

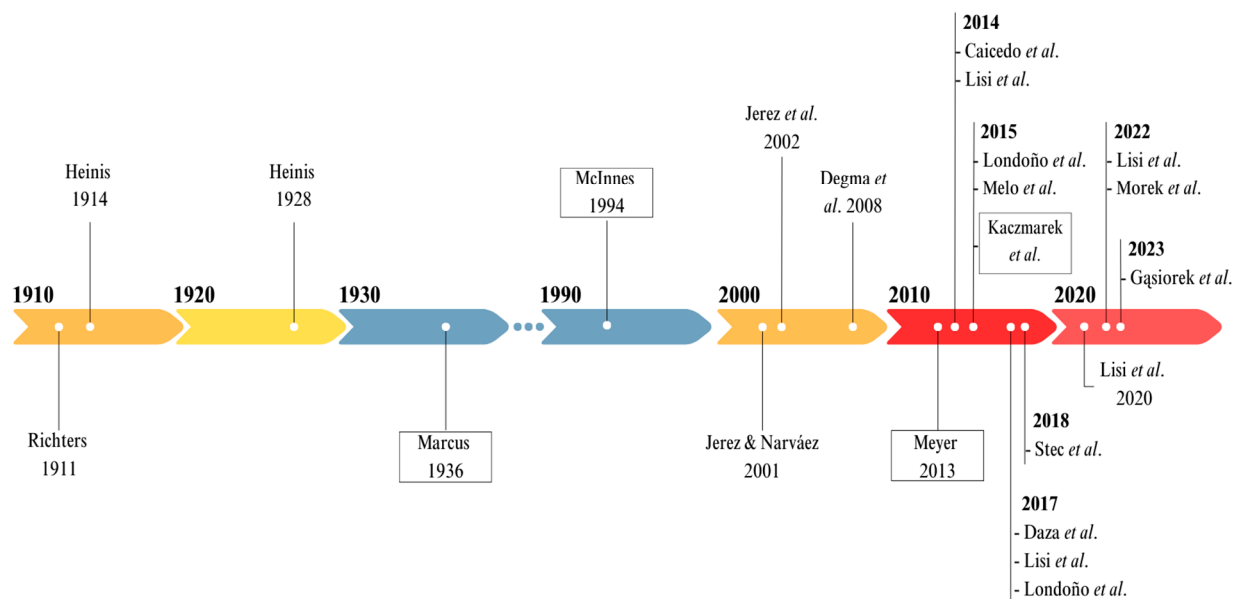


Figure 1. Timeline depicting scientific publications contributing to the knowledge of tardigrade diversity in Colombia [15,16,18,20–23,31,32,38–40,45–48,52–54,56–59]. References enclosed by squares indicate review or data compilation studies.

Table 2. Checklist of valid and verified tardigrade nominal species for Colombia. Scientific collection: CCC—Centro de Colecciones Científicas (Universidad del Magdalena, Colombia); CLUA—Colección Limnológica (Universidad de Antioquia, Colombia); CLK—Collection of Łukasz Kaczmarek (Department of Animal Taxonomy and Ecology, A. Mickiewicz University, Poznań, Poland); CLM—Collection of Łukasz Michalczyk (Department of Invertebrate Evolution, Institute of Zoology and Biomedical Research, Jagiellonian University, Kraków, Poland); CB&P—Collection of Maria Grazia Binda and Giovanni Pilato (Department of Animal Biology “Marcello La Greca”, University of Catania, Italy); DZC—Department of Zoology (Comenius University, Bratislava, Slovakia); DE.IZBR Institute of Zoology and Biomedical Research (Jagiellonian University, Kraków, Poland); DATE—Department of Animal Taxonomy and Ecology (Institute of Environmental Biology, Adam Mickiewicz University, Poznań, Poland); IGH—Instituto de Genética Humana (Pontificia Universidad Javeriana, Bogotá, Colombia); IAvH—Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (Bogotá, Colombia); NHMD—Natural History Museum of Denmark (University of Copenhagen, Denmark). Department: ANT—Antioquia; ATL—Atlántico; BOL—Bolívar; BOY—Boyacá; CES—César; CUN—Cundinamarca; MAG—Magdalena; SUC—Sucre. Species in bold are those described from type material collected in Colombia. * The species *Echiniscus lineatus* was reported as *Echiniscus darie* and reassigned according to Gąsiorek et al. [34]. ** *Crenubiotus revelator* was initially recorded as *Macrobiotus cf. crenulatus* [48].

Taxa	Department	Distribution	Scientific Collection
Tardigrada Doyère, 1840 Heterotardigrada Marcus, 1927 Echiniscoidea Richters, 1926 Echiniscidae Thulin, 1928			
1. <i>Barbaria bigranulata</i> (Richters, 1907)	CUN [40]	Cosmopolitan	CLK, IGH
2. <i>Barbaria madonnae</i> (Michalczyk & Kaczmarek, 2006)	MAG [48]	Neotropical	CCC
3. <i>Bryodelphax kristenseni</i> Lisi, Daza, Londoño & Quiroga, 2017	CES [32]	Endemic	CCC
	MAG [32]		CCC
	BOL (This paper)		CCC
4. * <i>Echiniscus lineatus</i> Pilato, Fontoura, Lisi & Beasley, 2008	MAG [32,48]	Pantropical	CCC
5. <i>Echiniscus perarmatus</i> Murray, 1907	MAG [32]	Cosmopolitan	CCC
6. <i>Kristenseniscus kofordi</i> (Schuster & Grigarick, 1966)	CES [32]	Nearctic; Neotropical	CCC
	BOL (This paper)		CCC
	SUC (This paper)		CCC
7. <i>Pseudechiniscus santomensis</i> Fontoura, Pilato & Lisi, 2010	MAG (This paper)	Neotropical	CCC
Eutardigrada Richters, 1926 Apochela Schuster, Nelson, Grigarick & Christenberry, 1980 Milnesiidae Ramazzotti, 1962			
8. <i>Milnesium brachyungue</i> Binda & Pilato, 1990	MAG [52]	Neotropical	CCC
9. <i>Milnesium granulatum</i> Ramazzotti, 1962	CUN [40]	Neotropical, Nearctic, and Mediterranean	CLK, IGH
10. <i>Milnesium katarzynae</i> Kaczmarek, Michalczyk & Beasley, 2004	ATL (This paper)	Pantropical	CCC
	CUN [40]		CLK, IGH
	MAG [47,52]		CCC
11. <i>Milnesium kogui</i> Londoño, Daza, Caicedo, Quiroga & Kaczmarek, 2015	MAG [52]	Neotropical	CCC
12. <i>Milnesium krzysztofi</i> Kaczmarek & Michalczyk, 2007	CUN [40]	Neotropical	CLK, IGH
	MAG [48]		CCC

Table 2. Cont.

Taxa	Department	Distribution	Scientific Collection
Parachela Schuster, Nelson, Grigarick & Christenberry, 1980			
Hypsibiidae Pilato, 1969			
13. <i>Mixibius gibbosus</i> Lisi, Daza, Londoño & Quiroga, 2022	MAG [20]	Endemic	CCC
Itaquasconidae Bartoš {in Rudescu, 1964}			
14. <i>Adropion onorei</i> (Pilato, Binda, Napolitano & Moncada, 2002)	MAG [20]	Neotropical	CCC
15. <i>Itaquascon pilatoi</i> Lisi, Londoño & Quiroga, 2014	MAG [48]	Endemic	CCC
16. <i>Platicrista aluna</i> (Lisi, Daza, Londoño, Quiroga & Pilato, 2019)	MAG [55]	Endemic	CCC
Doryphoribiidae Gąsiorek, Stec, Morek & Michalczyk, 2019			
17. <i>Doryphoribius amazonicus</i> Lisi, 2011	CES [20]	Neotropical	CCC
	MAG [48]		CCC
18. <i>Doryphoribius gibber</i> Beasley & Pilato, 1987	MAG [31]	Nearctic; Neotropical	CCC
19. <i>Doryphoribius quadrituberculatus</i> Kaczmarek & Michalczyk, 2004	MAG [47]	Cosmopolitan	CCC
20. <i>Doryphoribius rosanae</i> Daza, Caicedo, Lisi & Quiroga, 2017	ANT (This paper)	Endemic	CLUA
	CES [31]		CCC
	MAG [31]		CCC
Adorybiotidae Stec, Vecchi & Michalczyk, 2020			
21. ** <i>Crenubiotus revelator</i> Lisi, Londoño & Quiroga, 2020	MAG [57]	Endemic	CCC
Macrobiotidae Thulin, 1928			
22. <i>Minibiotus pentannulatus</i> Londoño, Daza, Lisi & Quiroga, 2017	MAG [56]	Pantropical	CCC
23. <i>Paramacrobiotus danielae</i> Pilato, Binda, Napolitano & Moncada, 2001	CUN [40]	Neotropical	CLK, IGH
24. <i>Paramacrobiotus derkai</i> (Degma, Michalczyk & Kaczmarek, 2008)	BOY [53]	Endemic	CLK, CLM, CB&P, DZC, IAvH, and NHMD
25. <i>Paramacrobiotus lachowskae</i> Stec, Roszkowska, Kaczmarek & Michalczyk, 2018	MAG [54]	Endemic	DE.IZBR, DATE
26. <i>Paramacrobiotus sagani</i> Daza, Caicedo, Lisi & Quiroga, 2017	MAG [31]	Endemic	CCC

Currently, several research groups from Colombian Universities are working on documenting the biodiversity of tardigrades (e.g., Universidad del Magdalena, Universidad El Bosque, Universidad de Antioquia, Universidad del Atlántico, Universidad de Córdoba, and Universidad Javeriana) with the intention of creating reference collections of these organisms. However, at present, only the tardigrade collection of the non-insect invertebrate collection division of the Centro de Colecciones Científicas de la Universidad del Magdalena is formally recognized by the Alexander von Humboldt Institute, with a unique national collection identifier RNC: 207. Currently, this collection houses approximately 12,500 legally collected specimens, including type material (holotypes and paratypes) of nine species (Table 2). The dataset of this collection is published in the SiB Colombia and GBIF, which, as of 2023, had 12,352 occurrences [60]. These include records of species from Atlántico, Bolívar, Cesar, Magdalena, and Sucre. However, the datasets from the Global Biodiversity Information Facility (GBIF) report an additional 29 occurrences with coordinates (17 November 2023). Of these, six correspond to the record of the species *Paramacrobiotus derkai* Degma, Michalczyk & Kaczmarek, 2008 reported by Degma et al. [53]; this species was described based on type material collected near the Nevado del Cocuy,

the department of Boyacá. The remaining records consist of occurrences with very low taxonomic resolution, sometimes with unreliable identification (e.g., *Carphania* Binda, 1978; this genus has been recorded only once in the surroundings of Catania, Italia), and most times simply reported as “Tardigrada” by consulting firms.

It is worth mentioning that to date, there are no formal records of marine tardigrades for the country. Some zoological symposiums have featured presentations on records of marine genera, which have not yet been translated into scientific publications. Therefore, it could be said that this field remains largely unexplored in Colombia.

3.2. Faunistic Account

Phylum: Tardigrada Spallanzani, 1777

Class: Heterotardigrada Marcus, 1927

Order: Echiniscoidea Richters, 1926;

Family: Echiniscidae Thulin, 1928;

Genus: *Barbaria* Michalczyk, Gąsiorek, Morek & Stec, 2019);

Barbaria cf. *rufoviridis* (du Bois-Reymond Marcus, 1944).

Material Examined: five specimens, CLUA:TARD #000009. Locality: Universidad de Antioquia (Antioquia department), situated at 6°1'57" N 75°3'14" W, 1467 m a.s.l. Microhabitat: extracted from the moss species *Sematophyllum subpinnatum* (Brid.) (E. Britton.) growing on tree trunks partially exposed to sunlight.

Remarks: The individuals closely resemble the original description by du Bois-Reymond Marcus [24] and align with additional morphological studies [27,28]. Nevertheless, the absence of type material for this species avoids a comprehensive identification.

Type Locality: São Paulo, Brazil.

Geographic Distribution: originally documented in southern Brazil (type locality), Ecuador, and Argentina [24,27,28]. If the species is confirmed, its distribution range would be expanded to Colombia, specifically within the Antioquia department at the central campus of the University of Antioquia.

Genus: *Bryodelphax* Thulin, 1928;

Bryodelphax kristenseni Lisi, Daza, Londoño & Quiroga, 2017.

Material Examined: 27 specimens, CBUMAG:TAR #00023 (1 specimen), #01833 (3 specimens), #01834 (4 specimens), #01835 (3 specimens), #01836 (3 specimens), #01837 (2 specimens), #01838 (1 specimen), #01851 (3 specimens), #01852 (3 specimens), #01884 (3 specimens), and #01885 (1 specimen). Locality: Reserva Brasilair (Bolívar department). Samples were collected at three different localities: 9°54'21.5" N 75°11'12.3" W, 9°54'21.4" N 75°11'12.4" W, 9°54'16.1" N, 75°11'14.5" W, at an elevation of 350–378 m a.s.l. Microhabitat: specimens were extracted from samples collected from tree trunks, which contained bryophyte of the genus *Lejeunea*, as well as lichens of the genera *Syncesia*, *Porina*, *Graphis*, *Fissurina*, *Parmotrema*, *Anisomeridium*, and *Arthonia*.

Remarks: the characteristics of the specimens match those of the species.

Type Locality: Sierra Nevada de Santa Marta, Magdalena, Colombia.

Geographic Distribution: *B. kristenseni* had been exclusively documented in Colombia for the department of Magdalena. Its distribution range is expanded within Colombia to the Bolívar department in the present study.

Genus: *Kristenseniscus* Gąsiorek, Morek, Stec & Michalczyk, 2019;

Kristenseniscus kofordi (Schuster & Grigarick, 1966).

Material Examined: 46 specimens, CBUMAG:TAR #01862 (3 specimens), #01863 (3 specimens), #01864 (3 specimens), #01865 (2 specimens), #01866 (2 specimens), #01867 (3 specimens), #01868 (3 specimens), #01869 (3 specimens), #01871 (3 specimens), #01872 (3 specimens), #01873 (3 specimens), #01999 (3 specimens), #02000 (3 specimens), #02001 (3 specimens), #02002 (3 specimens), and #02003 (3 specimens). Locality: Reserva Brasilair (Bolívar department), situated at 9°54'19.7" N 75°11'10.4" W, at an elevation range of 367–371 m a.s.l., and Reserva Caracolí (Sucre department), positioned at 9°35'53.7" N 75°19'46.9" W, 405 m a.s.l. Microhabitat: specimens were found in samples growing on

a tree trunk, which contained a bryophyte of the genus *Lejeunea*, as well as lichens of the genera *Porina*, *Herpothallon*, *Parmotrema*, *Lecanora*, *Phaeographis*, and *Cryphonina*.

Remarks: the individuals were compared to the original description in Schuster and Grigarick [25] and all characters match.

Type Locality: Galapagos Islands, Ecuador.

Geographic Distribution: This species has been documented in Ecuador, Costa Rica, Colombia, North America, and Mexico [16,61]. In Colombia, this species had been previously reported only in the Cesar department [32]. This study extends its distribution to the Bolívar and Sucre departments.

Genus: *Pseudechiniscus* Thulin, 1911

Pseudechiniscus santomensis Fontoura, Pilato & Lisi, 2010

Material Examined: 69 specimens, CBUMAG:TAR #02035 (21 specimens), #02036 (27 specimens), and #02037 (21 specimens). Locality: San Lorenzo, Sierra Nevada de Santa Marta (Magdalena department), positioned at 11°05'36.7" N 74°04'52.8" W, 1510 m a.s.l. Microhabitat: specimens were extracted from an epiphytic sample which contained the bryophyte species *Groutiella chimborazensis* (Spruce ex Mitt.) Florsch, *Sematophyllum subpinnatum* (Brid.) E.Britton., and *Squamidium leucotrichum* (Taylor) Broth., and the genus *Lejeunea*.

Remarks: all of the observed characteristics of the specimens align with the description provided in Fontoura et al. [29].

Type Locality: São Tomé Island, Africa.

Geographic Distribution: initially identified in Africa, *P. santomensis* is now recorded to have an expanded distribution to South America in the Sierra Nevada de Santa Marta (Magdalena).

Class: Eutardigrada Richters, 1926;

Order: Apochela Schuster, Nelson, Grigarick & Christenberry, 1980;

Family: Milnesiidae Ramazzotti, 1962;

Genus: *Milnesium* Doyère, 1840;

Milnesium cf. *barbadosense* Meyer & Hinton, 2012.

Material Examined: 89 specimens, CBUMAG: TAR #01683 (6 specimens), #01684 (4 specimens), #01685 (4 specimens), #01686 (4 specimens), #01687 (4 specimens), #01688 (3 specimens), #01689 (4 specimens), #01690 (4 specimens), #01691 (4 specimens), #01692 (4 specimens), #01693 (4 specimens), #01694 (4 specimens), #01695 (4 specimens), #01696 (4 specimens), #01697 (3 specimens), #01698 (4 specimens), #01702 (1 specimen), #01704 (1 specimen), #01705 (2 specimens), #01707 (1 specimen), #01711 (2 specimens), #01712 (4 specimens), #01713 (4 specimens), #01714 (4 specimens), #01715 (2 specimens), #01717 (1 specimen), and #01723 (3 specimens). Locality: Reserva Campesina La Montaña (Atlántico department), positioned at 10°46'38.5" N 75°02'40.3" W, between 160 and 250 m a.s.l., and Santuario de Flora y Fauna "Los Colorados" (Bolívar department). Samples were collected at four different localities: 9°58'31.5" N 75°08'00.2" W, 9°58'24.4" N 75°08'07.6" W, 9°58'37.5" N 75°07'53.8" W, 9°55'25.9" N 75°06'16.6" W, 296 m a.s.l. Microhabitat: specimens were extracted from samples which contained the bryophyte genera *Lejeunea* and *Philonotis* and the lichen genera *Polyblastidium*, *Physia*, *Herpothallon*, and *Pyxine* growing on tree trunks.

Remarks: the species description is incomplete, leading to uncertainty regarding the specimen diagnosis in this study, despite sharing certain characteristics.

Type Locality: Barbados.

Geographic Distribution: The species has been recorded for Barbados. In the event that the diagnosis of our material is confirmed, it has been previously reported in Colombia, specifically in the Magdalena department [52], and this study would expand to the Atlántico and Bolívar departments.

Milnesium katarzynae Kaczmarek, Michalczyk & Beasley, 2004.

Material Examined: 1 specimen, CBUMAG:TAR #01908 (1 specimen). Locality: Reserva Luriza (Atlántico department), situated at 10°45'07.0" N 75°01'51.6" W, 147 m a.s.l.

Microhabitat: specimens were extracted from a lichen of the genus *Porina* growing on a tree trunk.

Remarks: the observed individual aligns with the characteristics of *M. katarzynae* as described in the type material [26].

Type Locality: China, Sichuan Province.

Geographic Distribution: *M. katarzynae* was previously documented in Colombia (Magdalena), China, and Costa Rica [26,40,47,62]. This study expands its recorded distribution within Colombia to the Atlántico department.

Order: Parachela Schuster, Nelson, Grigarick & Christenberry, 1980;

Family: Doryphoribiidae Gąsiorek, Stec, Morek & Michalczyk, 2019;

Genus: *Doryphoribius* Pilato, 1969;

Doryphoribius rosanae Daza, Caicedo, Lisi & Quiroga, 2017.

Material Examined: 5 specimens, CLUA:TARD #000009. Locality: Universidad de Antioquia (Antioquia department), situated at 6°15'57.1" N 75°34'14.0" W, 1.467 m a.s.l. Microhabitat: specimens extracted from the bryophyte species *Fabronia ciliaris* (Brid.) Brid. growing on soil and concrete, fully exposed to sunlight.

Remarks: the observed individuals closely align with the original description.

Type Locality: Sierra Nevada de Santa Marta, Colombia.

Geographic Distribution: Previously documented in Magdalena and Cesar. This record extends its recorded distribution, specifically within the department of Antioquia at the central campus of the Universidad de Antioquia.

Table 3. Checklist of tardigrades requiring verification or higher taxonomic resolution but representing distinct taxa present in Colombia with no ambiguity with others. CCC—Centro de Colecciones Científicas de la Universidad del Magdalena; CLUA—Colección Limnológica Universidad de Antioquia; CLK—Collection of Łukasz Kaczmarek (Department of Animal Taxonomy and Ecology, A. Mickiewicz University, Poznań, Poland); DZC—Department of Zoology, Comenius University, Bratislava, Slovakia; IGH—Instituto de Genética Humana, Pontificia Universidad Javeriana (Bogotá, Colombia). Department: ANT—Antioquia; ATL—Atlántico; BOL—Bolívar; CAU—Cauca; CES—Cesar; CUN—Cundinamarca; MAG—Magdalena; PUT—Putumayo; SAN—Santander; TOL—Tolima.

Taxa	Locality	Collection
Tardigrada Doyère, 1840 Heterotardigrada Marcus, 1927 Echiniscoidea Richters, 1926 Echiniscidae Thulin, 1928		
1. <i>Barbaria</i> cf. <i>rufoviridis</i> (du Bois Reymond Marcus, 1944)	ANT (This paper)	CLUA
2. <i>Claxtonia</i> sp. 1	BOY [58]	DZC
3. <i>Pseudechiniscus novaezeelandiae aspinosa</i> Iharos, 1963	MAG [47]	CCC
Eutardigrada Richters, 1926 Apochela Schuster, Nelson, Grigarick & Christenberry, 1980 Milnesiidae Ramazzotti, 1962		
4. <i>Milnesium</i> sp. nov.	PUT [59]	CLK, IGH
5. <i>Milnesium</i> cf. <i>barbadosense</i> Meyer & Hilton, 2012	ATL, BOL (This paper); CES, MAG [54]	CCC
Parachela Schuster, Nelson, Grigarick & Christenberry, 1980 Calohypsibiidae Pilato, 1969		
6. <i>Calohypsibius ornatus</i> (Richters, 1900)	CUN [23]	Without material
Hypsibiidae Pilato, 1969		
7. <i>Diphascon chilense</i> Plate, 1888	ANT, CUN, TOL [22,23]	Without material
8. <i>Diphascon pingue pingue</i> sensu lato (Marcus, 1936)	MAG [20]	CCC

Table 3. Cont.

Taxa	Locality	Collection
9. <i>Diphyscon</i> sp. <i>pingue</i> group	MAG [20]	CCC
10. <i>Hypsibius</i> cf. <i>allisoni</i> Horning, Schuster & Grigarick, 1978	MAG [20]	CCC
Itaquasconidae Bartoš {in Rudescu, 1964}		
11. <i>Notahypsibius arcticus</i> (Murray, 1907)	ANT, SAN [23,45]	Without material
Isohypsibiidae Sands, McInnes, Marley, Marley, Goodall-Copestake, Convey & Linse, 2008		
12. <i>Dianeia sattleri</i> sensu lato (Richters, 1902)	MAG [20,48]	CCC
13. <i>Fractonotus verrucosus</i> (Richters, 1900)	SAN [45]	Without material
Macrobiotidae Thulin, 1928		
14. <i>Minibiotus</i> cf. <i>pilatus</i> Claxton, 1998	MAG [48]	CCC
15. <i>Minibiotus intermedius</i> (Plate, 1888)	ANT, CAU, CUN, TOL [23]; MAG [47]; SAN [45]	CCC
Richtersiusidae Guidetti, Schill, Giovannini, Massa, Goldoni, Ebel, Förschler, Rebecchi & Cesari, 2021		
16. <i>Diaforobiotus</i> cf. <i>islandicus</i> (Richters, 1904)	CUN [40]	CLK, IGH
Ramazzottidae Sands, McInnes, Marley, Goodall-Copestake, Convey & Linse, 2008		
17. <i>Ramazzottius oberhaeuseri</i> (Doyère, 1840)	ANT, CAU, TOL [23]	Without material

3.3. Distribution and Checklist

The list of verified species records for Colombia includes 43 known species distributed across 11 departments, primarily in Magdalena and Cundinamarca (Figure 2, Tables 2 and 3). Of these, 26 species have been confirmed (Table 2), while the remaining 17 are completely distinguishable from others present in the country but require further confirmation or higher taxonomic resolution (Table 3). A total of 11 new species have been described based on Colombian specimens (Table 2). The species reported in this study for Atlántico, Bolívar, and Sucre are the first records for these departments.

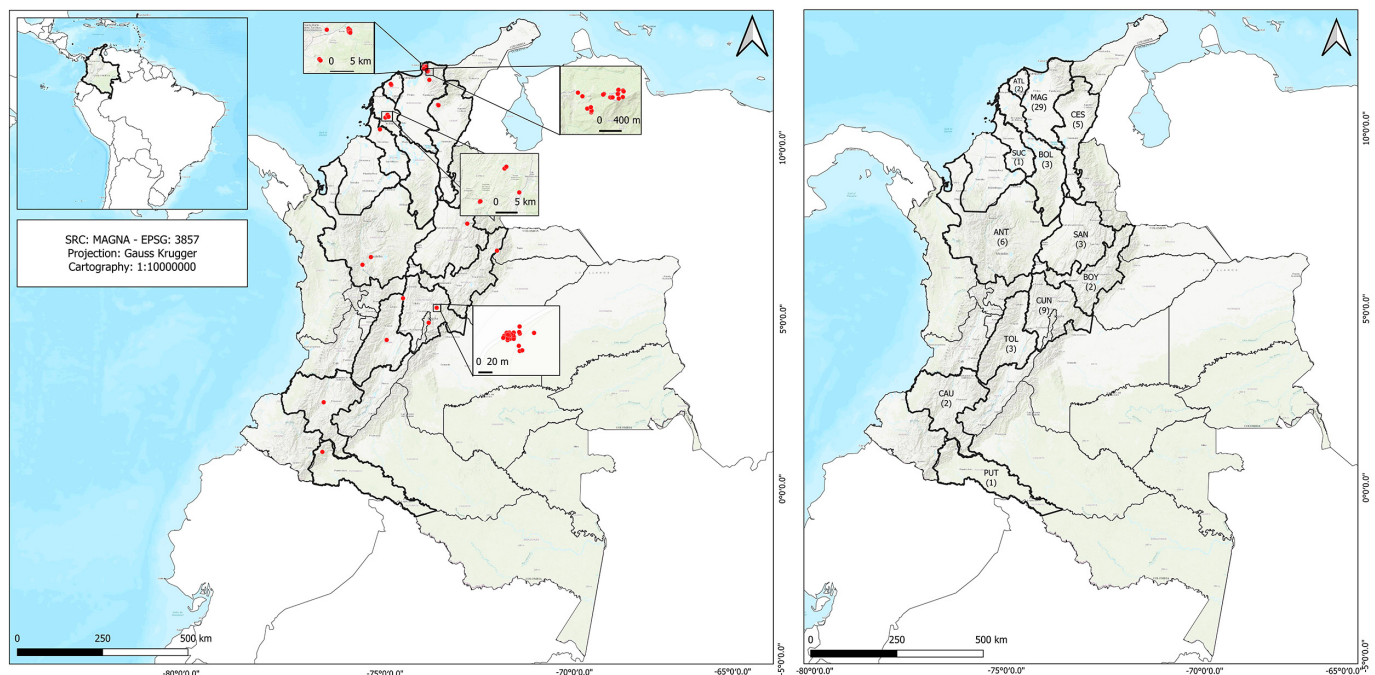


Figure 2. On the left is a map of Colombia displaying tardigrade records of the 43 species present in the country, based on collections and information available in the scientific literature (a total of 144 records). On the right is a map of Colombia illustrating its political division by departments, with

the values in brackets corresponding to the number of species, including those requiring verification but not exhibiting ambiguity with others (Table 3), recorded per department. Department: ANT—Antioquia; ATL—Atlántico; BOL—Bolívar; BOY—Boyacá; CAU—Cauca; CES—Cesar; CUN—Cundinamarca; MAG—Magdalena; PUT—Putumayo; SAN—Santander; SUC—Sucre; TOL—Tolima.

Although for the country, there are records of species whose diagnosis is incomplete or questionable (see Table 1) due to various causes, some of them represent taxa that can at least be counted as present in Colombia (and in some cases can represent a valid genus record). This is because we have carefully checked and compared all past records (with the pertinent information) in the literature. We ascertained that such taxonomic entities have unmistakable differences between them and the species whose presence and diagnosis has been confirmed in the country. Thus, they represent taxa requiring a more meticulous study for establishing their true taxonomic identity (refer to Table 3) but are distinct from all of the others in the checklist of the country (Tables 2 and 3).

4. Discussion and Conclusions

In general, the knowledge of tardigrade biodiversity is scant for Central and South American countries. Although the initial records date back more than 100 years, there are extensive information gaps concerning the richness and geographic representation of tardigrades in Colombia. Records exist for only 12 out of the 32 departments into which the country is politically divided, and there are no formal records of marine tardigrades. Approximately 80% of the country remains unexplored, and the fact that the more explored regions, such as the Magdalena department, have yielded the discovery of 10 new species suggests that uncharted or minimally explored territories may harbor numerous additional novelties for the tardigrade taxonomy and biodiversity.

While acknowledging the initial efforts toward documenting the biodiversity of tardigrades in Colombia [21–23,39,45], and with the aim of standardizing the knowledge of species present in the country, this study recommends that those records formally reported in scientific literature and represented in scientific collections ensure that any taxonomic verification or adjustments can be applied. Consequently, our analysis indicates that to date, 43 known species are present in Colombia: 26 records acknowledged by the literature (Table 2) and 17 regarding species (Table 3) whose presence is questionable but are considered distinct taxa which are undoubtedly different from others found in Colombia. These 43 species represent 23 genera and 11 families.

Scientific collections represent repositories of biodiversity and consequently are the heritage of nations and humanity [63]. Type specimens or replicas of specimens used to describe new species and specimens upon which new records are made should be housed in collections within the country of their collection. While the absence of specific tardigrade collections hindered this procedure in the past, the surge in tardigrade research in Colombia has necessitated the establishment of these spaces, and there is now at least one formally recognized collection (Centro de Colecciones Científicas de la Universidad del Magdalena (CCC)) with dedicated curators for this group. Therefore, this work serves as an invitation for future studies aimed at documenting tardigrade biodiversity to consider depositing their specimens in this collection or in others that are currently in the process of being established. This also promotes good practices in scientific research and publication by ensuring that the material on which the research is based has been legally collected, as stipulated by Colombian law for scientific collections [64].

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Institutional Review Board Statement: Samples for this study were legally collected under the permit “Permiso Marco de Recolección de Especímenes de Especies Silvestres de la Diversidad Biológica con fines de investigación científica no comercial”, resolution 1293 (2013), expedited by the Autoridad Nacional de Licencias Ambientales (ANLA) granted to the Universidad del Magdalena. Samples from the University of Antioquia were legally collected under the permit “Permiso Marco de Recolección de Especímenes de Especies Silvestres de la Diversidad Biológica con Fines de Investigación Científica no Comercial” resolution 0524 (2014), expedited by ANLA granted to the Universidad del Antioquia.

Data Availability Statement: The data presented in this study can be accessed in the manuscript.

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