**Tardigrada of the Caribbean island of Dominica (West Indies)**

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**ABSTRACT**

In June 2009 we surveyed the terrestrial Tardigrada of Dominica, the most northerly of the Windward islands of the Lesser Antilles in the Caribbean sea. Out of 112 moss, lichen, liverwort and leaf litter samples, 35 had tardigrades, representing 10 genera and 25 species or groups. This survey increases the number of species reported from Dominica from 3 to 25, more than the total recorded from any other West Indian island. Twelve species found in Dominica are cosmopolitan or belong to cosmopolitan species groups. Eight species are new to the fauna of the West Indies, one is new to the fauna of the Americas, and at least one is endemic to Dominica.

**Key words:** Caribbean fauna, tardigrades, West Indies, water bears, biogeography.

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**INTRODUCTION**

The first investigations of water bears (Phylum Tardigrada) in the West Indies were made in the mid-20th century, when du Bois-Reymond Marcus (1960) found four species in the Netherlands Antilles. Since then there have been few studies of terrestrial and freshwater tardigrades from islands of the Caribbean sea. These studies have been limited to the Greater Antilles islands of Puerto Rico (Fox and García-Moll, 1962; Beasley, 1981; Jaime Jerez, 2003), the Dominican Republic (Schuster and Toftner, 1982; Kaczmarek et al., 2007), Cuba (Kaczmarek and Michalczyk, 2002) and Grand Cayman (Meyer, 2011), and in the Lesser Antilles, Curaçao (du Bois-Reymond Marcus, 1960), Los Testigos (du Bois-Reymond Marcus, 1960), Saint Lucia (Iharos, 1982), Barbados (Meyer and Hinton, 2012), and Dominica (Meyer, 2012), and a new Dominican species described by Meyer (2012).

The West Indian island of Dominica, officially the Commonwealth of Dominica is approximately 750 km², and is the most northerly of the Windward islands. Volcanic in origin, Dominica has a very rugged topography with elevations of 1447 m. Unlike many Caribbean islands, it retains large expanses of virgin tropical wet rainforest (James, 2004). Yearly rainfall in the mountains ranges from 5000 to 9000 mm.

This paper provides the first survey of the Tardigrada from Dominica.

**METHODS**

**Sampling**

Sampling was conducted from 18 to 23 June 2009. In total, we collected 112 moss, lichen, liverwort and leaf litter samples. All samples were stored in paper envelopes until laboratory processing, when they were soaked overnight and examined with a stereoscopic microscope (Nikon SMZ-U Zoom 1:10; Nikon, Tokyo, Japan). Specimens were mounted on slides in polyvinyl lactophenol and examined using phase contrast microscopy (Nikon Eclipse 50i).

Tardigrades were identified using keys and descriptions in Nelson and McInnes (2002), Ramazzotti and Maucci (1983), Pilato and Binda (2010) and by reference to the primary literature. Tardigrade taxonomic nomenclature follows Guidetti and Bertolani (2005), Degma and Guidetti (2007) and Degma et al. (2012). Comments on tardigrade biogeography are based on McInnes (1994). Species are considered cosmopolitan if they meet the criterion of Pilato and Binda (2001), namely that they have been found in five or more biogeographical realms.

**Localities**

1. 15 20.77°N, 61 22.16°W, 348 m asl: Saint Paul parish, Archbold Tropical Research and Education Center, tropical rainforest, 18, 21, 23 June 2009 collected 49 samples-8 moss, 4 moss plus lichen, 4 lichen, 2 liverwort and 19 leaf litter.
2. 15 19.59°N, 61 20.52°W, 483 m asl: Saint Paul parish, Morne Trois Pitons National Park, Middleham falls, tropical rainforest, 19 June 2009 collected 13 samples-8 moss, 4 liverwort and 1 leaf litter.
3. 15 20.43°N, 61 18.35°W, 779 m asl: Saint Lucia (Iharos, 1982), Barbados (Meyer and Hinton, 2012), and Dominica (Meyer, 2012), and a new Dominican species described by Meyer (2012).
4. 15 35.02°N, 61 28.24°W, 51m asl: Saint John parish, Cabrits National Park, dry tropical forest, 19 June 2009 collected 6 samples-4 moss and 2 leaf litter.
5. 15 23.44°N, 61 18.39°W, 415 m asl: Saint David
parish, Emerald pool, tropical rainforest, 19 June 2009 collected 22 samples-13 moss, 1 liverwort and 3 leaf litter.

vi. 15 31.43°N 61 25.17°W, 538 m asl: Saint Peter parish, Syndicate trail, Northern Forest Preserve, tropical rainforest, 20 June 2009 collected 14 samples-9 moss, 1 lichen, 1 liverwort and 3 leaf litter.

vii. 15 31.43°N 61 25.17°W, 538 m asl: Saint Peter parish, Morne Diablotin Trail, Northern Forest Preserve, 19 June 2009 collected 1 sample-moss.

RESULTS

Only 35 of 112 samples of cryptogams and leaf litter contained tardigrades and their eggs. In these samples, 265 specimens and 12 eggs (representing 10 genera and 23 species or species groups) were found.

List of species:

i. *Echiniscus barbarae* Kaczmarek and Michalczyk, 2002
   LOCALITIES: 1
   MATERIAL: 4 specimens from 1 moss sample
   REMARKS: The first record outside the *locus typicus* (Cuba island) (Kaczmarek and Michalczyk, 2002).

ii. *Echiniscus cavagnaroi* Schuster and Grigarick, 1966
   LOCALITIES: 1
   MATERIAL: 1 specimen from 1 lichen sample
   REMARKS: Species known from few localities in North, South and Central America (McInnes, 1994). Previously reported also from the West Indies (Dominican Republic) (Schuster and Toftner, 1982).

iii. *Pseudechiniscus brevimontanus* Kendall-Fite and Nelson, 1996
   LOCALITIES: 1
   MATERIAL: 1 specimen from 1 moss sample
   REMARKS: The first record outside the *locus typicus* (North America) (Kendall-Fite and Nelson, 1996).

iv. *Pseudechiniscus cf. suillus*
   LOCALITIES: 1 and 2
   MATERIAL: 59 specimens from 5 samples of lichen, liverwort and moss.
   REMARKS: It is a cosmopolitan species group with many very similar species, known from many localities through the world (McInnes, 1994). Previously reported from the West Indies in Dominica, Dominican Republic and Puerto Rico (Beasley, 1981; Schuster and Toftner, 1982; Meyer, 2012).

v. *Milnesium* sp. 1
   LOCALITIES: 1 and 2
   MATERIAL: 3 specimens and one exuvium (with four eggs) from one moss sample.
   REMARKS: This species has a smooth cuticle, six peribuccal lamellae, a cylindrical buccal tube and [2-2][2-2] claw configuration.

vi. *Milnesium* sp. 2
   LOCALITIES: 1 and 4
   MATERIAL: 4 specimens from lichen and moss samples.
   REMARKS: This species has a smooth cuticle, six peribuccal lamellae, a cylindrical buccal tube and [2-2][2-2] claw configuration.

vii. *Milnesium cf. tardigradum*
   LOCALITIES: 1 and 4
   MATERIAL: 9 specimens and one exuvium (with four eggs) from nine moss, lichen and leaf litter samples.
   REMARKS: These specimens meet the criteria of Michalczyk et al. (2012a, b) for *Milnesium cf. tardigradum*, a cosmopolitan species group (McInnes, 1994). The full identification is not possible because the specimens were not oriented nor mounted adequately for morphometric analysis.

viii. *Diphascon (Diphascon) pingue* (Marcus, 1936)
   LOCALITIES: 1
   MATERIAL: 2 specimens from one moss sample.
   REMARKS: This species belongs to cosmopolitan *pingue* group of very similar species which can be determined only by morphometric characters (Fontoura and Pilato, 2007). Our specimens perfectly corresponded to the redescription in Pilato and Binda (1997/1998). It is the first report from the West Indies.

ix. *Hypsibius convergens* (Urbanowicz, 1925)
   LOCALITIES: 1
   MATERIAL: 3 specimens from one banana leaf litter sample.
   REMARKS: Considered as cosmopolitan in the past, it is most likely a group of very similar species found throughout the world (McInnes, 1994), see also Kaczmarek and Michalczyk (2009). Previously, it was found in West Indies on St. Lucia (Iharos, 1982).

x. *Astatumen trinacriae* (Arcidiacono, 1962)
   LOCALITIES: 6
   MATERIAL: 2 specimens from one lichen and moss sample.
   REMARKS: Holarctic species. It is the first report of this species from the West Indies.

xi. *Doryphoribius flavus* (Iharos, 1966)
   LOCALITIES: 6
   MATERIAL: 26 specimens plus four eggs in exuvium from two moss samples.
   REMARKS: Cosmopolitan species, previously found in Dominican Republic.

xii. *Doryphoribius quadrituberculatus* Kaczmarek and Michalczyk, 2004
    LOCALITIES: 1
    MATERIAL: 4 specimens from two moss samples.
    REMARKS: The first record outside the *locus typicus* (Costa Rica) (Kaczmarek and Michalczyk, 2004).

xiii. *Doryphoribius taiwanus* X. Li and H. Li, 2008
     LOCALITIES: 1
x. **Macrobiotus echinogenitus** Richters, 1904  
**Localities:** 1, 6  
**Material:** 27 specimens from six moss, lichen and leaf litter samples.  
**Remarks:** Cosmopolitan species, but it probably represents a group of species. Previously it was found in West Indies on Curacao (du Bois-Reymond Marcus, 1960).

xv. **Macrobiotus cf. harmsworthi** #1  
**Localities:** 1, 6  
**Material:** 25 specimens from three samples of moss and lichen on trees and one leaf litter sample.  
**Remarks:** Cuticles smooth, colourless/white. The correct identification of this species is possible only based on the adults and eggs (Kaczmarek et al., 2011). The **Macrobiotus harmsworthi** group is cosmopolitan and had been previously reported in West Indies from Barbados, Puerto Rico and Los Testigos (du Bois-Reymond Marcus, 1960; Beasley, 1981; Meyer and Hinton, 2012).

xx. **Minibiotus fallax** Pilato, Claxton and Binda, 1989  
**Localities:** 1 and 6  
**Material:** 2 specimens from two moss and lichen samples.  

DISCUSSION

Among the islands of the West Indies, only Grand Cayman, Hispaniola (Dominican Republic portion) and Puerto Rico have hitherto been systematically surveyed...
for terrestrial tardigrades. Our survey increases the number of tardigrade species known to occur on Dominica from three to 25, a number more than that of any other West Indian island.

Twelve of 25 species found in Dominica are cosmopolitan or belong to cosmopolitan species groups. Eight species are new to the fauna of the West Indies, one is new to the fauna of the Americas, and at least one is endemic to Dominica. It is worth noting that only 31% of samples collected had tardigrades; large numbers of samples from multiple sites need to be taken to get a true picture of tardigrade species richness. No survey, including this one, has collected freshwater tardigrades; when such habitats are included in West Indian sampling, the number of recorded species will doubtless increase.

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