NEW RECORDS OF THE ISOPOD *Leidya distorta* INFESTING THE MANGROVE CRAB *Ucides cordatus* FROM SOUTH AMERICA*

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ABSTRACT

The Neotropical region has a large diversity of crabs. However, the diversity of the parasites infesting these crustaceans is still poorly known. In this study, we recorded three new occurrences of the isopod bopyrid *Leidya distorta* on *Ucides cordatus* from Southern Brazil and North-Eastern Venezuela. Crabs were collected in mangroves of Venezuela (Cumaná) and Brazil (Cananéia and São Vicente). A total of 281 crabs were captured in these localities and dissected in the laboratory to verify parasitism by *L. distorta*. Three of these crabs were infested with *L. distorta*. Parasitic prevalences in the crabs were generally very low (1.1%), and differed according to localities: Cananéia (2.6%) and São Vicente (2.2%) were slightly higher than in Cumaná (0.5%). Here, we present new records of *L. distorta* infesting the mangrove crab *U. cordatus* from South America and reviewed the brachyuran that serve as host to *L. distorta*.

Key words: crab; Brazil; Venezuela; parasitism; bopyridae; isopoda.

NOVOS REGISTROS DE *Leidya distorta* INFESTANDO O CARANGUEJO-UCÁ *Ucides cordatus* NA AMÉRICA DO SUL

RESUMO

A região Neotropical tem uma grande diversidade de caranguejos. No entanto, a diversidade de parasitos infestando esses crustáceos ainda é pobremente conhecida. No presente estudo, foram registrados três novas ocorrências de *Leidya distorta* em *Ucides cordatus* no Sudeste do Brasil e no Nordeste da Venezuela. Os caranguejos foram coletados em manguezais da Venezuela (Cumaná) e do Brasil (Cananéia e São Vicente). Um total de 281 caranguejos foram capturados nessas localidades e dissecados no laboratório para verificar a presença de *L. distorta*. Apenas três caranguejos foram infestados com o bopirídeo *Leidya distorta*. A prevalência nos caranguejos foram muito baixa (1.1%), e diferiram de acordo com as localidades: levemente alta em Cananéia (2.6%) e São Vicente (2.2%), comparada com Cumaná (0.5%). Este estudo apresenta novas ocorrências de *Leidya distorta* infestando o caranguejo-uçá *Ucides cordatus* na América do Sul, bem como uma revisão dos braquiúros que servem de hospedeiro para *Leidya distorta*.

Palavras-chave: caranguejo; Brasil; Venezuela; parasitismo; bopyridae; isopoda.

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INTRODUCTION

Isopods associated with crustacean hosts show a broad distribution around the world (SMIT *et al*., 2014). According to WILSON (2008), isopods are a diverse group of crustaceans, with more than 10,300 species found in several environments, with 7.7% represented by parasitic isopod epicarideans. Specifically, Bopyridae is represented by 369 genres and 638 species described (WILLIAMS and BOYKO, 2012), being approximately 586 species of this family associated with decapods (BOYKO and WILLIAMS, 2009).

Bopyrid isopods are macroparasites with an indirect life cycle that involves two hosts, both crustaceans (LESTER, 2005). Most of them are found in the branchial chambers of shrimps, for instance, *Probopyrus* spp., (MASUNARI *et al*., 2000 and GOPALAKRISHNAN *et al*., 2017) or attached to the pleon of hermit and brachyuran crabs, for example, Athelginae (AN, 2009; WILLIAMS and BOYKO, 2012). According to LESTER (2005), the cryptoniscus that is a free-swimming larvae that seek out a definitive host settles between the gill lamellae and after moulting a few times, migrates to the roof of the branchial chamber and later mature into a female in a decapod host.

Specifically, the mangrove crab *Ucides cordatus* (Linnaeus, 1763) has been found infested with *Leidya distorta* (Leidy, 1855) for the first time in the Northeast Brazil (LEMOS DE CASTRO, 1973). *Leidya distorta*, an isopod species of the family Bopyridae (ROCCATAGLIATA and JORDÁ, 2002; BOYKO *et al*., 2016) has also been found in crabs of the genus *Uca* spp., from New Jersey, USA (LEIDY, 1855; ROCCATAGLIATA and JORDÁ 2002) to the Rio de La Plata estuary, Argentina (ROCCATAGLIATA and JORDÁ, 2002; JORDÁ and ROCCATAGLIATA, 2002) in Table 1.

However, there is little information about this bopyrid infesting *U. cordatus* in the east coast of South America.

In this study, we recorded three new localities of *L. distorta* infestation in the mangrove crab *U. cordatus*, in two latitudinal separated regions on the Atlantic coast of South America (North-Eastern Venezuela and Southern Brazil), and also reviewed the hosts for this bopyrid species.

Table 1. List of brachyuran crabs species used as host by *Leidya distorta* (Isopoda, Bopyridae).

Hosts	Locality	Region	Reference
Ocypodidae			
Uca pugilator	Atlantic City, New Jersey, USA	NA	Leidy (1855)
	Beaufort, North Carolina, USA	NA	Pearse (1951)
Uca pugnax	Savannah, Georgia, USA	NA	Bourdon & Bowman (1970)
	Guanabara, Rio de Janeiro, Brazil	SA	Lemos de Castro (1973)
Uca minax	Savannah, Georgia, USA	NA	Bourdon & Bowman (1970)
Uca sp.	Sapelo Islands, Georgia, USA	NA	Bourdon & Bowman (1970)
Uca sp.	Port-de-France, Guadeloupe	CA	Bourdon & Bowman (1970)
Uca spinicarpa	Chelem, Yucatan, Mexico	NA	Guillen-Hernandez *et al* (2013)
Uca vocator	El Sodorro, Trinidad	CA	Bourdon & Bowman (1970)
Uca uruguayensis	Río de la Plata, Argentina	SA	Roccatagliata & Jordá (2002)
Ucididae			
Ucides cordatus	Natal, Rio Grande do Norte, Brazil	SA	Lemos de Castro (1973)
	Caucaia, Ceará, Brazil	SA	Lemos de Castro (1973)
	Cananéia, São Paulo, Brazil	SA	Present study
	São Vicente, São Paulo, Brazil	SA	Present study
	Cumaná, Sucre, Venezuela	SA	Present study

NA, North America; CA, Central America; SA, South America

METHODS

Mangrove crabs were collected from two localities in Southern Brazil (São Vicente and Cananéia) and one in Venezuela (Cumaná, Sucre State) (Figure 1).

A total of 85 crabs were captured between February 2012 to June 2015 in mangrove areas in both localities (São Vicente: 23º58'51.4"S; 46º24'24.5"W; Cananéia: 24°59'9.80"S; 47°56'12.24"W) in Southern Brazil. The sampling area ranged between 12,500 and 27,500 m^2, with a predominance of *Rhizophora mangle* L. trees (>70%). In these localities, crabs were caught using "braceamento", a manual method where the fisherman uses his arm to extract the crabs from their burrows (PINHEIRO and FISCARELLI, 2001) and legally permitted by the Brazilian law (BRASIL, 2011).

In Cumaná, the crabs were collected between February and August 2011 at the spillway of the sea close to the Manzanares river, Sucre State, Venezuela (10°27'43.11"N, 64°6'07.99"W). This site had a predominant vegetation of *Avicennia germinans* (L.) with a scarce presence of *R. mangle* at the border of the spillway. With local fishermen help, fishing net pieces were placed over the burrow entrances. Crabs trying to exit the burrows got entangled in the net and could be easily captured. Afterwards, they were put in an icebox and transported to the laboratory.

In the laboratory, the specimens of *U. cordatus* were sexed by inspection of the abdomen shape and number of pleopods (PINHEIRO and FISCARELLI, 2001), and the carapace width (CW) measured with a precision vernier caliper (0.05 mm). Later, the specimens were sacrificed and searched for bopyrids in their branchial chambers. The collected isopods were identified as *L. distorta* based on the descriptions given by RICHARDSON (1908), BOURDON and BOWMAN (1970), and ROCCATAGLIATA and JORDÁ (2002).

The bopyrids were fixed in 70% ethanol, photographed, and the prevalence was calculated as the number of hosts infested divided by the number of hosts examined expressed as a percentage (BUSH *et al*., 1997).

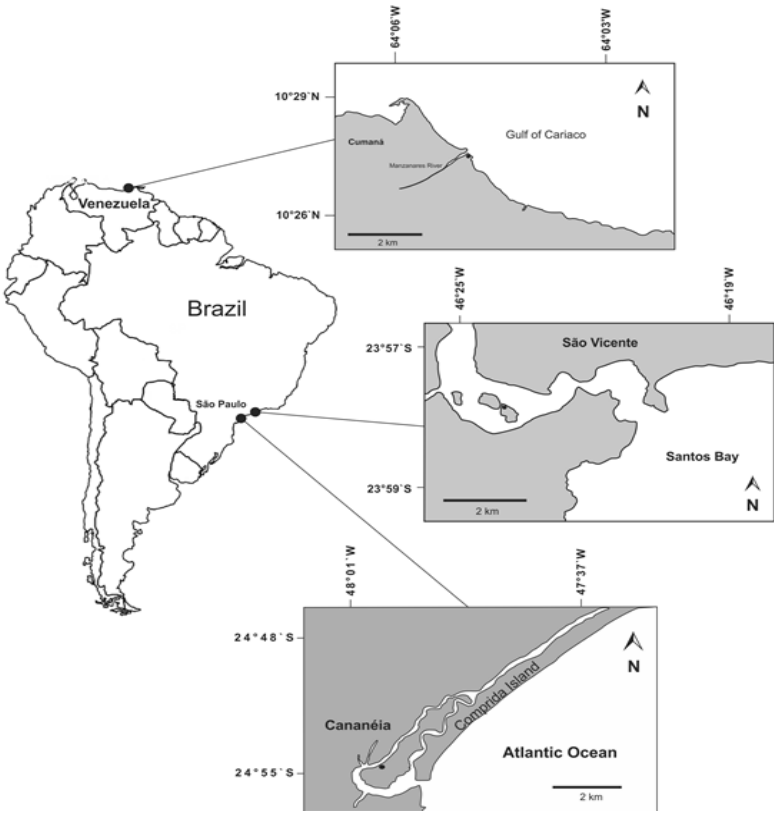

Figure 1. Map showing three localities from South American region (Cananéia and São Vicente, at São Paulo State, Brazil; and Cumaná, Sucre State, Venezuela) from which Leidya distorta individuals were registered.

RESULTS

A total of 281 crabs were collected from the three localities (Cananéia, N = 40; São Vicente, N = 45; and Cumaná, N = 196). From this total, three specimens (one of each locality) were infested with different developmental stages of the bopyrid *L. distorta* (Figures 2, 3, and 4). The prevalence of *L. distorta* in *U. cordatus* was very low throughout the study from the three localities, with a mean value of 1.1%. The prevalence was slightly higher for Cananéia (2.6%) and São Vicente (2.2%) when compared to Cumaná (0.5%) (Table 2). One juvenile of *L. distorta* was found in each locality. A total of six male bopyrids and an adult female of *L. distorta* were found only in Cananéia (Table 2), parasitizing a mature adult male of *U. cordatus* (73 mm CW).

The adult female of this species is characterised by possessing a large bilobed head, with a strong dorsal anterior carina (HE, head; Figure 2A). Older mature female possesses a fully expanded and spherical marsupium and well-developed dorsal bosses (Figure 2 A, B). First two pereomere (1-2) are shorter. The three following segments are the largest (3-5) and are sub equal in length, about twice as long as the first. The 6-7th pereomeres are a little shorter than the fifth, and the seventh is half as long as the sixth. The seven pairs of pereopods are small and feeble, with the propodus and dactyls forming a prehensile hand. The terminal segment is furnished with a single pair of elongated pinnate appendages, the uropod (Figure 2 C). The pleopods are biramous (Figure 2 C, D), and the antennae are little developed. The maxillipeds with palp are present, articulated or not. There are also five pairs of incubatory plates, which overlap each other on the ventral side, completely inclosing the marsupial cavity. The pereonites with prominent mid-dorsal projections (i.e., dorsal bosses on the pereon) is an important diagnosis which is characteristic for this species in adult females (Figure 2 A). The juvenile females (Figure 3) differs from the adult in its narrower and elongated form, the thorax not much distended, and more symmetrical segments of the pereon (Figure 3 A), which do not have the mid-dorsal projections as in the adult. They also have the segments of the pereon more distinctly separated and the lateral appendages more elongated (Figure 3 A, B). Also, the oostegites in the juvenile females are much smaller than the ones in the adult females, and the marsupial pouch greatly reduced in size (Figure 3).

The marsupial pouch is never filled with eggs at this stage. The male of this species possessed a body narrow and elongated (Figure 4). Head than long; frontal margins straight, with anterolateral angles rounded (Figure 4 C). The posterior portion is somewhat wider than the anterior (Figure 4 D). Vestiges of ocular pigment visible from posterior part of the head. The first pair of antennae (Figure 4 B) composed of three joints, the second pair composed of seven, the last two being minute and tipped with setae. The seven thoracic segments are separated from each other by lateral incisions (Figure 4 A, B) so that the lateral margins are not continuous. There are seven pairs of prehensile legs. The six abdominal segments are perfectly distinct, separated from each other by lateral incisions, and decrease gradually in width, from the first to the sixth, which carries a pair of elongated, tapering appendages, the uropod (Figure 4 D). The pleopods are rudimentary.

Table 2. Infestation levels of *Leidya distorta* (Isopoda, Bopyridae) registered in three localities from South America in the present study.

Locality	NGC	NPC	Instars of *Leidya distorta**			Prevalence (%)
			Male	Juvenile female	Adult female	
Cananéia, Brazil (MZUSP 35962)**	40	1	6	1	1	2.55
São Vicente, Brazil (MZUSP 35961)**	45	1	-	1	-	2.22
Cumaná, Venezuela	196	1	-	1	-	0.51
Total	281	3	6	3	1	1.07

NGC, numbers of gathered crabs; NPC, numbers of parasitized crabs; *Number of developmental stages of *Leidya distorta* according to the description of Roccatagliata and Jordá (2002). **The voucher parasite specimens were deposited in the Museum of Zoology of the University of São Paulo (MZUSP), Brazil.

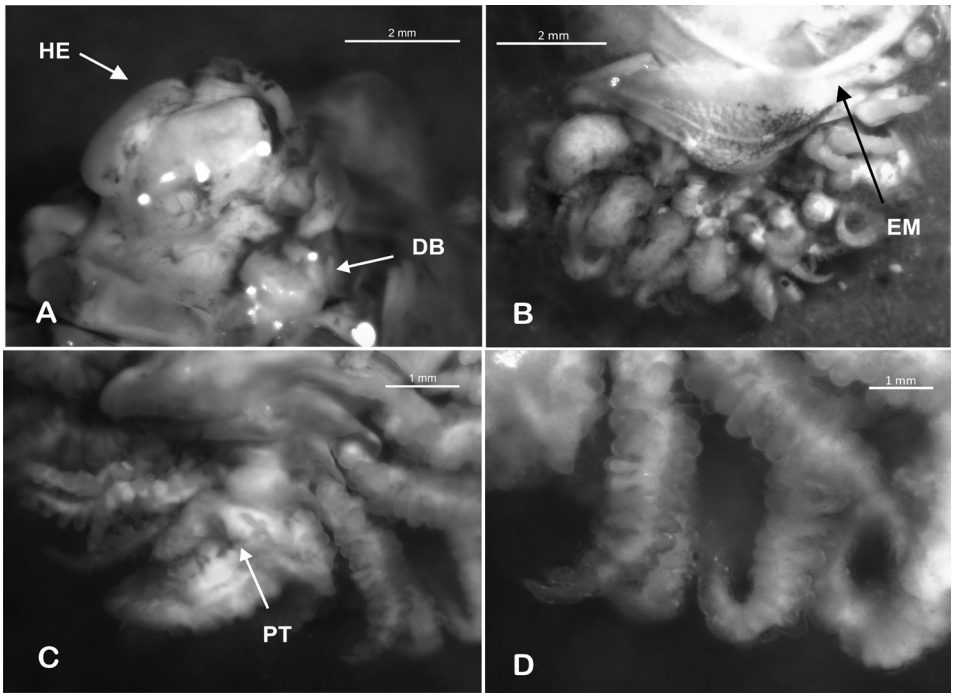

Figure 2. *Leidya distorta* (Leidy, 1855). Adult female specimen: A, head and well developed dorsal bosses; B, marsupium fully expanded and spherical; C, pleopods; and pleotelson; D, pleopods. Where: DB, dorsal bosses; EM, expanded marsupium; HE, head; PT, pleotelson. Scale bar = 2 mm (A and B), 1 mm (C and D).

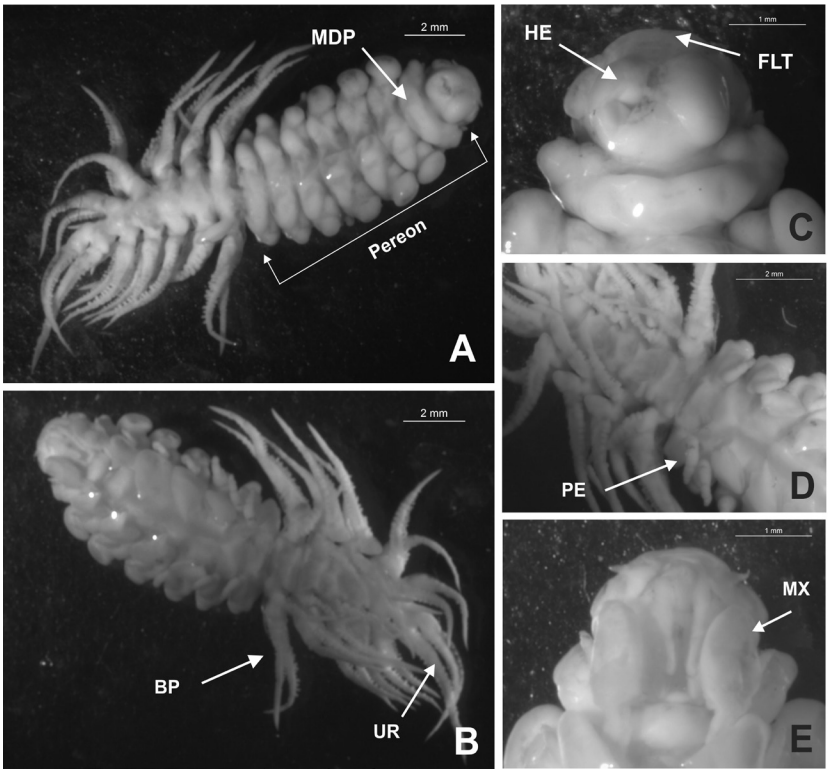

Figure 3. *Leidya distorta* (Leidy, 1855). Juvenile female specimen: A, dorsal view; B, ventral view; C, head and lamina view; D, pleopods and pereopods view; and E, antennae and maxilliped view. Where: BP, biramous pleopod; FLT, frontal lamina truncate; HE, head; MDP, mid dorsal projections; MX, maxillipeds; PE, pereopods; UR, uropod. Scale bar = 2 mm (A, B and D), 1 mm (C and D).

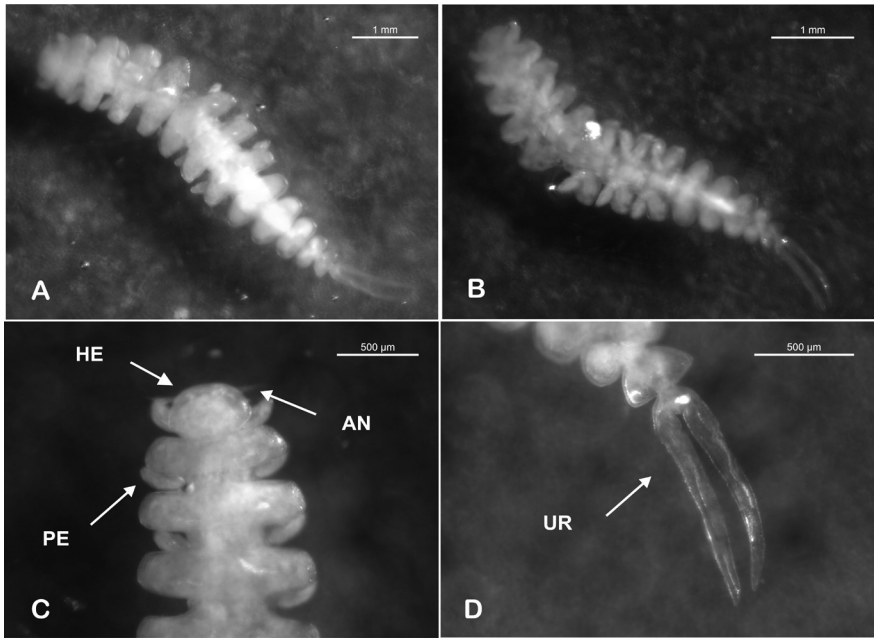

Figure 4. *Leidya distorta* (Leidy, 1855). Male specimen: A, dorsal view; B, ventral view; C, head view; D, pair of elongated uropod. Where: AN, antennae; HE, head; PE, pereopods; UR, uropod. Scale bar = 1 mm (A and B), 500 µm (C and D).

DISCUSSION

In this study, we recorded for the first time the infestation of the mangrove crab *U. cordatus* by *L. distorta* in Venezuela, and it also represents the second report in Brazil. LEMOS DE CASTRO (1973) reported the first record of this isopod infestation previously in *U. cordatus* in two different localities of Northeast Brazil (Natal, Rio Grande do Norte State; and Caucaia, Ceará State). Thus, in the present study, we expanded the distribution of this bopyrid by adding three new localities, two in the Southeast region (Cananéia and São Vicente, São Paulo state, Brazil) and another one in the Northwest of South America (Cumaná, Sucre state, Venezuela).

This bopyrid has also been found in species of the genus *Uca* in several regions of the American continent coast (Table 1), since New Jersey, USA (LEIDY, 1855; ROCCATAGLIATA and JORDÁ, 2002) until Rio de La Plata estuary, Argentina (ROCCATAGLIATA and JORDÁ, 2002; JORDÁ and ROCCATAGLIATA, 2002). From all the known species of the genus *Uca* in Brazil, this bopyrid only infests the fiddler crab *U. pugnax* (Smith) (LEMOS DE CASTRO, 1973). Moreover, according to an important revision about the diversity of parasitic isopods associated with crustacean hosts, the poor knowledge about Neotropical bopyrids could be due to a lack of sufficient sampling in many of these regions (e.g. east coast of South America), rather than reflecting real biogeographic patterns for bopyrids (WILLIAMS and BOYKO, 2012).

According to LESTER (2005), adult males are much smaller than the females (Figure 4) and are usually found attached to their pleopods. JORDÁ and ROCCATAGLIATA (2002), found a very low prevalence in both sexes of *Uca uruguayensis* Nobili, 1901 (males, 12%; and females, 5%). The data given by these authors are similar, with the lowest prevalence found in the populations of *U. cordatus* in São Vicente (Brazil), Cananéia (Brazil), and Cumaná (Venezuela). LEMOS DE CASTRO (1973), also found a very low prevalence in *U. cordatus* from Rio Grande do Norte and Ceará states, and in *U. pugnax* from Rio de Janeiro, all considered Brazilian sites. Moreover, LAFFERTY and KURIS (2009) point out that the infestation pattern of *L. distorta* is often aggregated, which could explain the lowest prevalence in mangrove crabs. In addition, single infestations in adult female bopyrid isopods are generally accompanied by a single dwarf male consort (ROCCATAGLIATA and JORDÁ, 2002; LAFFERTY and KURIS, 2009). Rarely two parasites can occur together in the branchial chamber or under

the abdomen of the decapod hosts, and never three or more (LAFFERTY and KURIS, 2009), but this fact was not verified in the present study.

Therefore, the low prevalence of bopyrid species in brachyuran crabs and the reported numbers of undescribed species in recent studies suggest a large yet undescribed fauna of marine isopoda, especially in the tropical Atlantic waters (POORE and BRUCE, 2012). Our results revealed a lower prevalence of *L. distorta* infesting the mangrove crab *U. cordatus* from South America.

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