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Tick fauna of giant anteaters (*Myrmecophaga tridactyla*) and southern tamanduas (*Tamandua tetradactyla*) in the Metropolitan Region of Sorocaba, São Paulo, Brazil[1]

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ABSTRACT.- Teixeira RHF, Costa ALM, Ferreira RVM, Amorim M, Gazeta GS, Bitencourth K, Siqueira L, Christan EL, Roque VRP, Labruna MB, Martins TF. **Tick fauna of giant anteaters (*Myrmecophaga tridactyla*) and southern tamanduas (*Tamandua tetradactyla*) in the Metropolitan Region of Sorocaba, São Paulo, Brazil.** *Pesquisa Veterinária Brasileira 46:e07767, 2026*. Universidade Paulista "Júlio de Mesquita Filho", Botucatu, SP, Brazil. E-mail: rhftzoo@hotmail.com

The systematic collection of parasites from wild animals provides valuable information, highlighting the relationship between hosts and parasites. The study of ixodofauna in wild animals supports research on the transmission of pathogens that cause diseases in *in situ* and *ex situ* situations. Over a three-decade period, from 1994 to 2024, 2,709 ticks attached to giant anteaters (*Myrmecophaga tridactyla*) and southern tamanduas (*Tamandua tetradactyla*) were collected from the Metropolitan Region of Sorocaba, São Paulo state, Brazil. Tick collections were performed on free-ranging wild animals, which were immediately maintained under human care at the Sorocaba Zoo, and the carcasses of wild giant anteaters and southern tamanduas were sent to the Zoo and the University of Sorocaba. The ixodids were identified with the aid of taxonomic keys and deposited in two acarological collections. The tick species *Amblyomma aureolatum*, *Amblyomma brasiliense*, *Amblyomma calcaratum*, *Amblyomma dubitatum*, *Amblyomma nodosum*, *Amblyomma sculptum*, *Amblyomma tigrinum*, *Dermacentor nitens*, *Rhipicephalus microplus* and *Amblyomma* sp. larvae were collected from giant anteaters. Ticks collected from southern tamanduas included *A. aureolatum*, *A. calcaratum*, *A. dubitatum*, *A. nodosum*, *A. sculptum* and *Amblyomma* sp. larvae. Over the three decades of research, the tick species *A. sculptum* and *A. nodosum* represented 41.0% and 34.5% of the ticks collected from giant anteaters and southern tamandua, respectively. Over the period of collections, the nomenclature of ticks and the order of anteaters was modified, as were the methods of identification of ixodids, highlighting the importance of updating data on the relationships between ectoparasites and hosts.

INDEX TERMS: Acari, Pilosa, wild animals, ectoparasites, Brazilian territory.

RESUMO.- **[Ixodofauna de tamanduás-bandeiras (*Myrmecophaga tridactyla*) e tamanduás-mirins (*Tamandua tetradactyla*) na Região Metropolitana de Sorocaba, São Paulo, Brasil.]** A coleta sistemática de parasitas em animais selvagens contribui com informações valiosas, destacando a relação entre hospedeiros e parasitas. O estudo da ixodofauna em animais silvestres ampara

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a investigação sobre a transmissão de patógenos, causadores de enfermidades em situações *in situ* e *ex situ.* Durante três décadas, de 1994 a 2024, foram coletados 2.709 carrapatos fixados em tamanduás-bandeiras (*Myrmecophaga tridactyla*) e tamanduás-mirins (*Tamandua tetradactyla*) da Região Metropolitana de Sorocaba, estado de São Paulo, Brasil. A coleta de carrapatos foi realizada em animais selvagens de vida livre, que foram imediatamente mantidos sob cuidados humanos no Zoológico de Sorocaba, e em carcaças de tamanduás-bandeiras e tamanduás-mirins que foram enviadas ao Zoológico e à Universidade de Sorocaba. Os ixodídeos foram identificados com auxílio de chaves taxonômicas e depositados em duas coleções acarológicas. As espécies de carrapatos *Amblyomma aureolatum*, *Amblyomma brasiliense*, *Amblyomma calcaratum*, *Amblyomma dubitatum, Amblyomma nodosum*, *Amblyomma sculptum*, *Amblyomma tigrinum, Dermacentor nitens*, *Rhipicephalus microplus* e larvas de *Amblyomma* sp. foram coletadas em tamanduás-bandeiras. E nos indivíduos de tamanduás-mirins foram coletadas as espécies de carrapatos *A. aureolatum*, *A. calcaratum, A. dubitatum*, *A. nodosum*, *A. sculptum* e larvas de *Amblyomma* sp. Ao longo das três décadas de pesquisas, as espécies de carrapatos *A. sculptum* e *A. nodosum* representaram 41,0% e 34,5% dos carrapatos coletados em tamanduá-bandeira e tamanduá-mirim, respectivamente. Ao longo do período das coletas a nomenclatura dos carrapatos e da ordem dos tamanduás foram modificadas, assim como os métodos de identificação dos ixodídeos, evidenciando a importância de atualizar os dados sobre a relação entre ectoparasitas e hospedeiros.

TERMOS DE INDEXAÇÃO: Acari, Pilosa, animais selvagens, ectoparasitas, território brasileiro.

INTRODUCTION

Ticks are invertebrate, hematophagous ectoparasites that transmit numerous pathogens that cause serious diseases, directly impacting their hosts (e.g., anemia) and, in extreme cases, causing death (Teixeira et al. 2017). Pathogen transmission occurs during ectoparasites' blood feeding on their hosts, and ticks are considered the second most important vector group for bioagents in public health (Saraiva et al. 2014).

Globally, approximately 1,000 tick species have been identified, divided into three families: Ixodidae, Argasidae, and Nuttalliellidae (Guglielmone et al. 2010, Dantas-Torres et al. 2019, Barros-Battesti et al. 2024). Ticks parasitize amphibians, reptiles, birds, and mammals, with most hosts being wild animals.

The Ixodidae family is the most important tick group in public health, as it acts as a vector for viruses, bacteria, and protozoa (Pinter et al. 2021). These ixodids are known as "hard ticks" due to the presence of a complete dorsal shield in males and an incomplete one in females and immature forms.

In Brazil, the Ixodidae family is represented by five genera (*Amblyomma*, *Dermacentor*, *Ixodes*, *Haemaphysalis*, and *Rhipicephalus*). The genus *Amblyomma* is of major medical importance and is the most species-rich, with a total of 35 species (Estrada-Peña et al. 2010, Guglielmone et al. 2021, Barros-Battesti et al. 2024, Tojal et al. 2025).

Although some tick species are host-specific, ticks can move between different groups of animals, including domestic, wild, and human hosts. As these hosts get closer, the exchange of tick species occurs more frequently, increasing the incidence of zoonotic pathogen transmission. Therefore, identifying ixodids on wild animals and understanding the parasite-host interaction is of great importance for studying the epidemiology of pathogens that affect both animals and humans (Bastos et al. 2016).

The order Pilosa comprises three genera of Brazilian anteaters — the giant anteater (*Myrmecophaga* sp.), the southern tamandua (*Tamandua* sp.), and the silky anteater (*Cyclopes* sp.) (Miranda 2014, Miranda et al. 2018). These animals have a wide geographic distribution, inhabiting various biomes across the country. They prefer preserved areas and avoid large urban centers, but they are increasingly coming into proximity with domestic animals and humans. According to case studies from the Metropolitan Region of Sorocaba (MRS), vehicle collisions are a primary cause and a major threat to the lives of giant anteaters (Teixeira & Miranda 2012).

The carcasses of free-ranging animals, as well as those of animals rescued from nature, are excellent sources of biological material for scientific research. Other viable sources for ectoparasites from wild animals include zoos, wildlife screening centers (CETAS), and universities, as they also receive animals directly from the natural environment for clinical/surgical care at veterinary hospitals or for necropsy at animal pathology services.

The Metropolitan Region of Sorocaba (MRS) comprises 27 municipalities (total area of approximately 11,611.48 km^2) with an estimated population of 2.5 million people, traversed by two major highways and experiencing the greatest agricultural expansion among the main metropolitan regions in Brazil (Santana-Chaves et al. 2021). In the past, the landscape was predominantly composed of the Atlantic Forest biome. However, the area is now characterized by a transition biome between the Atlantic Forest and the Cerrado, popularly known as "Cerradão" (Mota Junior et al. 2020). Wild animals share this space with agricultural expansion, domestic animals, and disorganized urbanization, compounded by biome modifications.

Some authors have already documented the occurrence of ixodids on anteaters in Brazil, for both free-ranging individuals and animals kept under human care. The following tick species have been reported to parasitize the giant anteater (*Myrmecophaga tridactyla*): *Amblyomma aureolatum*, *Amblyomma auricularium*, *Amblyomma brasiliense*, *Amblyomma cajennense* sensu lato (s.l.), *Amblyomma calcaratum*, *Amblyomma coelebs*, *Amblyomma dubitatum*, *Amblyomma goeldii*, *Amblyomma humerale*, *Amblyomma naponense*, *Amblyomma nodosum*, *Amblyomma ovale*, *Amblyomma parvum*, *Amblyomma pseudoconcolor*, *Amblyomma sculptum*, *Amblyomma triste*, immatures of *Amblyomma* sp., *Rhipicephalus microplus*, and *Rhipicephalus sanguineus* s.l. (Cutolo et al. 2000, Evans et al. 2000, Labruna et al. 2002, Brum et al. 2003, Guglielmone at al. 2003, Martins et al. 2004, Figueiredo et al. 2010, Garcia et al. 2013, Martins et al. 2015, Muñoz-García et al. 2019, Nascimento et al. 2017, Oliveira et al. 2017, Teixeira et al. 2017, Muñoz-García et al. 2019, Szabó et al. 2019, Martins et al. 2023).

On the southern tamandua (*Tamandua tetradactyla*), the following tick species have been collected: *A. auricularium*, *A. calcaratum*, *A. coelebs*, *A. goeldii*, *A. humerale*, *A. naponense*, *A. nodosum*, *A. parvum*, *A. sculptum*, *R. sanguineus* s.l., and immatures of the genus *Amblyomma* (Labruna et al. 2002, Brum et al. 2003, Guglielmone et al. 2003, Martins et al. 2004, 2015, 2017, 2023, Quadros et al. 2009, Figueiredo et al. 2010, Lavina et al. 2011, Nascimento et al. 2017, Oliveira et al. 2017, Teixeira et al. 2017, Muñoz-García et al. 2019).

In the present study, we present the results and update the information on ticks parasitizing giant anteaters and southern tamanduas, based on three decades of research and collections in the MRS.

MATERIALS AND METHODS

Ethical approval. This study was not submitted to the Ethics Committee on the Use of Animals (CEUA) of the Sorocaba Zoo, "Parque Zoológico Municipal Quinzinho de Barros" (Quinzinho de Barros Municipal Zoological Park – PZMQB), because the biological samples were obtained from wild animals kept in a zoological collection under legal authorization. According to Article 22 of Ordinance No. 748/2022 of the "Instituto Chico Mendes de Conservação da Biodiversidade" (Chico Mendes Institute for Biodiversity Conservation – ICMBio), the collection and transport of biological samples obtained under *ex situ* conditions do not require authorization from the "Sistema de Autorização e Informação em Biodiversidade" (Biodiversity Authorization and Information System – SISBIO). Additionally, the institution involved in the collection holds a valid Wildlife Management Authorization (AM No. 8040/2011) issued by the "Secretaria de Meio Ambiente, Infraestrutura e Logística" (Secretary of Environment, Infrastructure, and Logistics – SEMIL).

Tick collections were performed on specimens of giant anteaters (*Myrmecophaga tridactyla*) and southern tamanduas (*Tamandua tetradactyla*) that were sent to the Sorocaba Zoo and the "Universidade de Sorocaba" (Uniso). Regarding the origin of the hosts, the vast majority were live animals from the wild and the MRS. However, the study also included animals received and maintained under human care at the Sorocaba Zoo (without contact with domestic animals), as well as wild-animal carcasses with ticks attached that were destined for the PZMQB and Uniso.

The collection period was from 1994 to 2024, resulting in three uninterrupted decades of collections. The hosts were identified by technicians from the PZMQB and professors from Uniso. Ticks were removed manually and carefully during the animal rescue, reception, and management procedures at the institutions. Later, during routine examinations of animals at the zoo and university, ticks were collected, stored in plastic containers with 70% ethanol, and properly identified.

The material was sent to the Laboratory of Ticks and Other Wingless Vectors, "Instituto Oswaldo Cruz" (IOC), Rio de Janeiro/RJ, and to the Laboratory of Parasitic Diseases of the "Departamento de Medicina Veterinária Preventiva e Saúde Animal" (Department of Preventive Veterinary Medicine and Animal Health – VPS) at the "Faculdade de Medicina Veterinária e Zootecnia" (Faculty of Veterinary Medicine and Animal Science – FMVZ) of the "Universidade de São Paulo" (USP), São Paulo/SP. The ticks were identified using a stereomicroscope with the help of dichotomous taxonomic keys (Aragão & Fonseca 1961, Guimarães et al. 2001, Barros-Battesti et al. 2006, Martins et al. 2010, Martins et al. 2024). The material was deposited in the "Coleção de Artrópodes Vetores Ápteros de Importância em Saúde das Comunidades" (Collection of Wingless Arthropod Vectors of Importance in Community Health – CAVAISC) and the "Coleção Nacional de Carrapatos Danilo Gonçalves Saraiva" (National Tick Collection Danilo Gonçalves Saraiva – CNC) of the FMVZ-USP.

RESULTS

Over three decades, from 1994 to 2024, a total of 2,709 tick specimens were collected. These represented nine different species (*Amblyomma aureolatum*, *Amblyomma brasiliense*, *Amblyomma calcaratum*, *Amblyomma dubitatum*, *Amblyomma nodosum*, *Amblyomma sculptum*, *Amblyomma tigrinum*, *Dermacentor nitens*, and *Rhipicephalus microplus*), as well as immature forms of *Amblyomma*, found on both giant anteaters (*Myrmecophaga tridactyla*) and southern tamanduas (*Tamandua tetradactyla*) (Table 1).

Table 1. Relationship between anteater hosts and ixodid species, including parasitic stage and the percentage of each species, in the Metropolitan Region of Sorocaba, São Paulo, Brazil

Host	Tick	L	N	F	M	T	%
Giant anteater (*Myrmecophaga tridactyla*)	*Amblyomma* sp.	105	-	-	-	105	5.7
	Amblyomma aureolatum	-	-	1	1	2	0.1
	Amblyomma brasiliense	-	-	1	1	2	0.1
	Amblyomma calcaratum	-	-	233	441	674	36.6
	Amblyomma dubitatum	-	-	1	-	1	0.1
	Amblyomma nodosum	-	-	30	188	218	11.8
	Amblyomma sculptum	3	530	82	142	757	41.1
	Amblyomma tigrinum	-	-	-	4	4	0.2
	Dermacentor nitens	-	-	38	28	66	3.6
	Rhipicephalus microplus	-	-	11	4	15	0.8
Sub total		108	530	397	809	1,844	100
Southern tamandua (*Tamandua tetradactyla*)	*Amblyomma* sp.	248	-	-	-	248	28.7
	A. aureolatum	-	-	10	-	10	1.2
	A. calcaratum	-	-	42	79	121	14.0
	A. dubitatum	-	-	1	1	2	0.2
	A. nodosum	-	-	75	220	295	34.1
	A. sculptum	-	87	42	60	189	21.8
Sub total		248	87	170	360	865	100
TOTAL		356	617	567	1,169	2,709	-
%		13.1	22.8	20.9	43.2	100	-

L = larva, N = nymph, F = female, M = male, T = total.

The tick species with the highest prevalence on giant anteaters were *A. sculptum*, *A. calcaratum* (Fig. 1), and *A. nodosum*, representing 41.1%, 36.6%, and 11.8% of the collected ixodids, respectively. On southern tamanduas, *A. nodosum* (Fig. 2) and *A. sculptum* were the most prevalent tick species, representing 34.1% and 21.8%, respectively, followed by *A. calcaratum* (14.0%). The other tick species represented low percentages of the total collected, ranging from 0.1% to 3.6%. Regarding the developmental stage of the ticks, 64.1% were adults and 35.9% were immature. In terms of sex, males accounted for 43.2% and females for 20.9% of the collected ixodids. Finally, in southern tamanduas, larvae of the genus *Amblyomma* represented 28.7% of the collected ticks (Table 1).

DISCUSSION

The climatic conditions of the MRS favor the development of the tick life cycle. Despite a noticeable dry season, the region's rainfall and average temperatures are favorable. Another characteristic of the region is the high concentration of domestic animals, pets, and livestock, combined with the increasing expansion of the urban footprint.

There are no wildlife screening centers in the municipalities near Sorocaba. Therefore, the PZMQB and Uniso, both located in Sorocaba/SP, serve as reference points for receiving and providing care to wild animals. On average, three anteaters are received per year at the Sorocaba Zoo. It is essential to incorporate ectoparasite inspection into the routine management of wild animals, even for deceased individuals, by examining carcasses received or rescued from the environment. This activity does not involve high costs or require advanced technical skills, yet it is rarely practiced in institutions that manage wild animals.

Scarce information on dichotomous taxonomic keys for species diagnosis of the ectoparasite, or even the absence or destruction of part of the gnathosoma, makes species-level identification of ticks difficult or impossible. Due to this fact, in both host species, all collected ixodid larvae were identified at the genus taxonomic level (*Amblyomma*).

The fact that only adults of *Amblyomma calcaratum* and *Amblyomma nodosum* were collected from anteaters in this study is consistent with the literature, which indicates that *Myrmecophaga tridactyla* and *Tamandua tetradactyla* are the main hosts for the adult stage of these two tick species. Their immature stages (larvae and nymphs) are found mainly on Passeriformes birds (Barros-Battesti et al. 2024). On the other hand, both immature (nymphs) and adult forms (males and females) of *Amblyomma sculptum* were found in abundance on both anteater species, especially on the giant anteater, indicating a possible primary importance of this anteater species in the wild cycle of *A. sculptum*, as recently suggested (Szabó et al. 2019). The presence of *Amblyomma* larvae in anteaters is consistent with other studies, as parasitism by immature stages of ixodid ticks is common in wild animals (Guimarães et al. 2001, Barros-Battesti et al. 2006).

The giant anteater was the host with the greatest variety of tick species, totaling nine distinct species grouped into three genera (*Amblyomma*, *Dermacentor*, and *Rhipicephalus*). This is possibly due to its habit of making long journeys in search of food, traveling through different biomes. This is different from southern tamandua, which presented five species, all from the genus *Amblyomma*. The southern tamandua has arboreal habits, preferring to move through the tree canopy in search of arboreal ants and termites and to find greater safety from predators. Another hypothesis for the difference in the number of tick species between hosts may be related to the animals' body mass. The adult giant anteater weighs an average of 40 kg. In comparison, the southern tamandua weighs an average of 8

Fig. 1. Adult female specimen of *Amblyomma calcaratum* parasitizing a giant anteater (*Myrmecophaga tridactyla*) in the Metropolitan Region of Sorocaba, São Paulo, Brazil.

Fig. 2. Adult female specimen of *Amblyomma nodosum* parasitizing a southern tamandua (*Tamandua tetradactyla*) in the Metropolitan Region of Sorocaba, São Paulo, Brazil.

kg, which is consistent with literature data on other mammals of the superorder Xenarthra (Kluyber et al. 2016).

Continuing the discussion on tick diversity in wild hosts, we found that ectoparasite species commonly associated with domestic animals are only found on giant anteaters. Specimens of *Dermacentor nitens* and *Rhipicephalus microplus*, ticks commonly found on equines and bovines, respectively, were collected attached to giant anteaters. It is likely that the proximity of these hosts facilitates the exchange of ectoparasites (Madder et al. 2012, Labruna & Faccini 2020). On the other hand, individuals of the tick species *Amblyomma brasiliense*, which are ectoparasites preferably found on wild peccaries (collared peccaries and white-lipped peccaries), were collected on giant anteaters in preserved areas far from large urban centers (Barros-Battesti et al. 2006, 2024). This finding highlights the presence of giant anteaters in different biomes (Atlantic Forest and Cerrado).

The species *Amblyomma aureolatum* has previously been reported in the literature as parasitizing southern tamandua (Guglielmone et al. 2021). In the present study, we found this tick on a giant anteater for the first time, since *A. aureolatum* is a proven vector of Brazilian Spotted Fever in the state of São Paulo, together with *A. sculptum*, given the importance of these two tick species to public health. Anteaters only play the role of transporting ticks from one place to another and are not expected hosts that amplify certain pathogens (e.g., rickettsiae) as far as we know. The tick species *Amblyomma dubitatum* has been recorded parasitizing giant anteaters, with both adult and immature forms present. However, for the southern tamandua host, only immature forms of *A. dubitatum* had been reported to date (Guglielmone et al. 2021). In the present study, we collected adult male and female specimens of this tick. The tick *Amblyomma tigrinum* has been identified parasitizing domestic animals (bovines, equines, swine, and canines) and two groups of wild animals (carnivores and ungulates) in landscapes with preserved green areas (Labruna et al. 2005, Guglielmone et al. 2021). It is worth noting that this study represents the first record of *A. tigrinum* parasitizing a giant anteater.

Over the course of the tick collection period, the scientific nomenclature for the "star tick" (*Amblyomma cajennense*) was updated. In the Brazilian Southeast region, it is currently named *A. sculptum*, with the nomenclature *A. cajennense* sensu stricto reserved for ticks in the central-northern region of Brazil (Nava et al. 2014, Martins et al. 2016). Another important point is that the taxonomic classification of the host order was also updated, replacing the term Edentata with Pilosa, which did not affect the present research.

The highest prevalence of ticks was found on wild animals from natural environments, whereas animals in zoological collections showed a low parasitic load. The number of ticks attached to hosts is also directly related to the animals' health status, with a tendency for a higher parasitic load in debilitated animals. This fact reinforces the importance of zoos and triage centers in studying the relationship between ectoparasites and wild hosts.

Different institutions are involved in research projects on ticks in wild animals, including zoos, triage centers, universities, and specialized acarology research laboratories. Each partner has a distinct role: zoos and triage centers are excellent sources of biological material, as they manage various groups of wild animals that serve as hosts for ticks. Research laboratories are essential for ectoparasite diagnosis, and universities play a fundamental role in training professionals and disseminating scientific output. Therefore, partnerships and formal agreements between institutions are welcome to promote quality scientific research on wild animals.

Finally, the states in the Brazilian Southeast region account for the highest levels of scientific production regarding ticks on wild animals. This is due to the concentration of the largest number of zoos, triage centers, and universities with parasitology laboratories, with a particular emphasis on the state of São Paulo.

CONCLUSIONS

The species *Amblyomma calcaratum*, *Amblyomma nodosum*, and *Amblyomma sculptum* represented the main ticks found on giant anteaters and southern tamanduas in the Metropolitan Region of Sorocaba (MRS) over the last 30 years. The greater diversity of tick species observed in giant anteaters compared to southern tamanduas may be related to differences in host ecology and body mass: giant anteaters are predominantly terrestrial, whereas southern tamanduas exhibit more arboreal habits. The ticks *Amblyomma aureolatum* and *Amblyomma tigrinum* are reported to parasitize giant anteaters for the first time.

Systematic collection of ectoparasites from wild animals sent to zoos, triage centers, and universities is an excellent source of information on the local tick fauna, as the parasitized animals reflect the parasite-host relationship of the region. Studies involving ixodids on wild animals are low-cost, low-complexity activities that, in turn, provide substantial information for public health surveillance.

It is important to emphasize the promotion of partnerships through agreements between institutions, as each entity has distinct characteristics or areas of operation. Zoos and triage centers are excellent sources of biological materials for scientific research. At the same time, laboratories and universities are proficient in ectoparasite identification and possess superior logistics and skilled professionals in their areas of expertise.

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Credit author statement.- Rodrigo Hidalgo Ericiclo Teixeira, Marinete Amorim, and Thiago Fernandes Martins were responsible for article writing, data analysis, and sample processing. Vitória Regina Pereira Roque and Marcelo Bahia Labruna contributed to article writing and data analysis. André Luiz Mota da Costa, Ronnie Von Matheus Ferreira, Gilberto Sales Gazeta, Karla Bitencourth, Liege Siqueira, and Emanuelle Lorena Christan performed data analysis. All authors participated in the article review.

Data availability statement.- Data on ticks are available in two national reference acarological collections and can be accessed by contacting the collection curators.

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