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Implementation of an innovative strategy to control scorpions in the Serra Negra, state of São Paulo, Brazil

Implementação de uma estratégia inovadora para o controle de escorpiões na Serra Negra, estado de São Paulo, Brasil

Implementación de una estrategia innovadora para el control de escorpiones en la Serra Negra, estado de São Paulo, Brasil

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Abstract
Scorpions represent a growing public health problem in the state of São Paulo, with the species *Tityus serrulatus* being the most prevalent. Public cemeteries are considered vulnerable areas with high scorpion collection, which sometimes disperse to adjacent properties. The objective of this study was to implement a complementary mechanism to the scorpion management carried out in cemeteries, aiming to reduce occurrences in properties in their surroundings. An inverted PVC pipe gutter was installed around the entire area of the cemetery, on the inside of the wall. The pipe joints were designed to create a structure that prevented cracks. To correct small gaps between the wall and the pipe installation, it was filled with expanding foam. It has been observed that cockroaches and scorpions are unable to cross the fixed gutter and do not reach homes. Between 2018 and 2021, there were 52 scorpions occurring in the surrounding homes. After this structure was installed, there were no more reports of scorpions in the surrounding houses. The results demonstrated a direct impact, preventing scorpions from escaping from the cemetery and entering neighboring houses, thereby positively impacting the safety of the population. This finding can be incorporated into public policies and the control of infestations of this arachnid, with significant implications for human health.
Keywords: Scorpion; Cemeteries; Epidemiological monitoring.

Resumo
Os escorpiões representam um problema crescente de saúde pública no estado de São Paulo, sendo a espécie *Tityus serrulatus* a mais prevalente. Cemitérios públicos são considerados áreas vulneráveis com alta concentração de escorpiões, que por vezes se dispersam para propriedades adjacentes. O objetivo deste estudo foi implementar um mecanismo complementar ao manejo de escorpiões realizado em cemitérios, visando reduzir a ocorrência em propriedades vizinhas. Uma calha de cano de PVC invertido foi instalada ao redor de toda a área do cemitério, na parte interna do muro. As juntas dos canos foram projetadas para criar uma estrutura que impedisse rachaduras. Para corrigir pequenas frestas entre o muro e a instalação dos canos, estas foram preenchidas com espuma expansiva. Observou-se que baratas e escorpiões não conseguem atravessar a calha fixa e não chegam às residências. Entre 2018 e 2021, houve 52 ocorrências de escorpiões nas residências vizinhas. Após a instalação dessa estrutura, não houve mais relatos de escorpiões nas casas vizinhas. Os resultados demonstraram um impacto direto, impedindo que os escorpiões escapassem do cemitério e entrassem nas casas vizinhas, impactando positivamente a segurança da

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população. Essa descoberta pode ser incorporada às políticas públicas e ao controle de infestações desse aracnídeo, com implicações significativas para a saúde humana.
Palavras-chave: Escorpião; Cemitérios; Monitoramento epidemiológico.

Resumen
Los escorpiones representan un creciente problema de salud pública en el estado de São Paulo, siendo la especie *Tityus serrulatus* la más prevalente. Los cementerios públicos se consideran zonas vulnerables con una alta concentración de escorpiones, que en ocasiones se dispersan a propiedades adyacentes. El objetivo de este estudio fue implementar un mecanismo complementario al manejo de escorpiones en cementerios, con el fin de reducir su presencia en propiedades cercanas. Se instaló una canaleta invertida de PVC alrededor de toda el área del cementerio, en la parte interior del muro. Las juntas de las tuberías se diseñaron para crear una estructura que evitara grietas. Para corregir pequeños huecos entre el muro y la instalación de la tubería, se rellenó con espuma expansiva. Se ha observado que las cucarachas y los escorpiones no pueden cruzar la canaleta fija y no llegan a las viviendas. Entre 2018 y 2021, se registraron 52 casos de escorpiones en las viviendas circundantes. Tras la instalación de esta estructura, no se registraron más casos de escorpiones en las viviendas circundantes. Los resultados demostraron un impacto directo, impidiendo que los escorpiones escapen del cementerio y entren en las casas vecinas, lo que repercute positivamente en la seguridad de la población. Este hallazgo puede incorporarse a las políticas públicas y al control de infestaciones de este arácnido, con importantes implicaciones para la salud humana.
Palabras clave: Escorpión; Cementerios; Monitoreo epidemiológico.

1. Introduction

Scorpions are chelicerate arthropods of the class Arachnida, order Scorpiones (Brazil, 2009). Currently, 23 families and over 2,500 species of scorpions are known worldwide (Rein, 2022). In Brazil, 4 families (Bothriuridae, Chactidae, Liochelidae, and Buthidae), 27 genera, and 182 species are found (Bertani et al., 2024). Four species of the genus *Tityus* (Buthidae) are considered the most medically relevant: *Tityus serrulatus* Lutz & Mello, 1922, *Tityus bahiensis* (Perty, 1833), *Tityus stigmurus* (Thorell, 1876), and *Tityus obscurus* (Gervais, 1843) (Lourenço, 2016).

The number of scorpion-related accidents has increased significantly in Brazil, particularly in the state of São Paulo. In Brazil, in 2019, there were 166,255 cases of scorpion stings, with 34,224 occurring in the state of São Paulo (Datasus, 2025; CVE, 2025a). Over the last 10 years, there has been a significant increase in scorpion stings in São Paulo, rising from 4,392 occurrences in 2007 to 42,054 in 2024.

In the state of São Paulo, the species that has caused most accidents is *T. serrulatus*, known as the yellow scorpion. It is the main species that causes serious accidents, with recorded deaths, mainly in children (Eloy et al., 2021). It has light yellow legs and tail, and a dark trunk, with the presence of a serration on the 3rd and 4th rings of the tail, with a body length of up to 7 cm and parthenogenetic reproduction (up to 20 offspring at a time) (Brazil & Porto, 2010). Previously restricted to Minas Gerais, this species of scorpion has expanded its distribution to the Northeast, Southeast, Central-West, and South of Brazil, with the advantage of adapting easily to the urban environment (MS, 2001).

Currently, environmental management is the fundamental technology for controlling scorpions of the species *T. serrulatus*, *T. bahiensis,* and *T. stigmurus*, which are prevalent in the state of São Paulo (CVE, 2025b). Control by mechanical capture, one by one, is still the most effective method, but extremely laborious for technicians/managers who, faced with large infestations, end up using chemical products even in defiance of the public policy for scorpion control implemented in 2009 in Brazil, which does not recommend their use because they have a dislodging effect, thus increasing the risk of accidents by this animal (Brazil, 2009).

Scorpions have adapted to various environments altered by humans in urban areas, and measures are needed to prevent their proliferation through control, capture (active search), and environmental management (Pimenta et al., 2019). There are areas, such as cemeteries, that are considered vulnerable to the presence of scorpions, due to the characteristics of the environment, which offer ideal conditions for the survival and reproduction of these animals, with a high volume of specimens being collected (Brasil & Brites-Neto, 2019).

Cemeteries have an abundance of shelters, such as tombs and graves that offer gaps, holes, and spaces between their structures, as well as tombstones and monuments, which can accumulate moisture and offer dark and protected places (Brites-Neto & Galassi, 2012). Additionally, the presence of insects, such as cockroaches, crickets, and other small arthropods, serves as the primary food source for scorpions, making the area attractive to this animal (Eickstedt et al., 1996). The low human traffic in certain areas of cemeteries allows scorpions to establish themselves without major disturbances, sometimes resulting in sightings in nearby houses.

The municipality of Serra Negra has been working continuously to respond to reports of scorpions. These reports originate from various locations but are primarily concentrated on properties situated near the municipal cemetery. The objective of this study was to implement a complementary mechanism to the scorpion management carried out in cemeteries, aiming to reduce occurrences in properties in their surroundings.

2. Methodology

An epidemiological survey was conducted, based on a documentary investigation of direct sources in the SINAN system and the Escorpio System, using a quantitative approach (Pereira et al., 2018) and employing simple descriptive statistics with data classes and absolute frequency and relative percentage frequency values (Shitsuka et al., 2014).

Information on the collection of scorpion specimens, referring to the period from 2019 to 2024, was extracted from the State Scorpion Notification System (Sistema Escorpio) of the Disease Control Coordination of the State Department of Health of São Paulo. This system is open to municipalities in the state of São Paulo, allowing them to record encounters/sightings of scorpions based on reports from the population or accidents registered in the Notifiable Injuries Information System (Sinan). The Scorpio System was implemented in 2018 and aims to record sighting information to prevent accidents (Gomes et al., 2019). Information was extracted on the number of municipalities with registered notifications, the total number of notifications received, the scorpion species present, and the number of scorpion specimens collected in cemeteries throughout the state of São Paulo. This information served as the basis for evaluating scorpion occurrences in the municipality of Serra Negra, São Paulo, Brazil.

Serra Negra is in the north of the state of São Paulo, 152 km from the capital of São Paulo, 70 km from Campinas, bordering the cities of Monte Alegre do Sul (8 km), Amparo (18 km), Lindóia (15 km), Itapira (39 km) and Socorro (35 km) (Serra Negra, 2025).

Known for being a Hydromineral and Climatic Tourist Resort in the state of São Paulo, Serra Negra was established as an indigenous village in 1820, located in the lands of Mogi Mirim, adjacent to the Mantiqueira range, which gave rise to the name of the town. According to data from the Brazilian Institute of Geography and Statistics (IBGE), in 2022, the municipality had a population of 29,894 inhabitants (IBGE, 2025).

The municipal cemetery occupies an area of 25,627 m^2 (Figure 1). It is in the center of the city of Serra Negra. After responding to a scorpion accident at a residence located in an urban area, the resident was advised to test the installation of an inverted PVC gutter on the outside of his wall, in an attempt to prevent the animal from entering the property. The results obtained were satisfactory, which raised the idea of placing them throughout the entire cemetery to stop the invasion of this arachnid into the surrounding homes.

Figure 1 – Area of the municipal cemetery (yellow line) of the municipality of Serra Negra. State of São Paulo, Brazil.

Source: Google Earth (2024).

PVC pipes measuring 100 mm (4 inches) and a 6-meter bar were purchased. The pipe was divided in half, yielding 12 meters of gutter. The installation was carried out on an internal wall, 1.80 meters above the ground (Figure 2). The gutters were installed by a company hired for this purpose, inverted, and fixed to the wall with plugs and screws. Screws and plugs were fixed every 20 centimeters to secure the gutter and provide greater support to the structure. As the cemetery wall has uneven surfaces, expanding foam was used to seal openings in some spaces. The gutter joints were designed to prevent grooves or mechanisms that would allow it to be passed through. After installing the gutters, chemical control measures for cockroaches were implemented in the municipal cemetery.

Figure 2 – Inverted PVC pipe structure installed around the municipal cemetery. (A) wall of property with installation of the device; (B) installation on the inside of the cemetery wall that borders houses. Municipal Cemetery of Serra Negra, state of São Paulo, 2024.

Source: Author's file (2024).

3. Results

Between 2019 and 2024, 529 municipalities in São Paulo (82.0% of the existing ones) registered information in the Escorpio System. There were 211,698 scorpion notifications, representing an annual average of 35,283 notifications/year. A total of 391,080 scorpions were collected (annual average = 65,180). The species *T. serrulatus* was the most prevalent, with 373,919 specimens collected, accounting for 95.6% of the total scorpions captured during the period.

The collection of specimens in cemeteries is presented in Table 1, showing the number of positive surveys. There was an increase in the number of municipalities that carried out collections in this environment over the period, as well as an increase in the number of scorpions captured. A higher percentage of positive surveys in cemeteries was observed starting from 2022. The year 2023 stands out, as 108,270 scorpion specimens were collected in 422 positive surveys carried out in cemeteries across 55 municipalities in São Paulo.

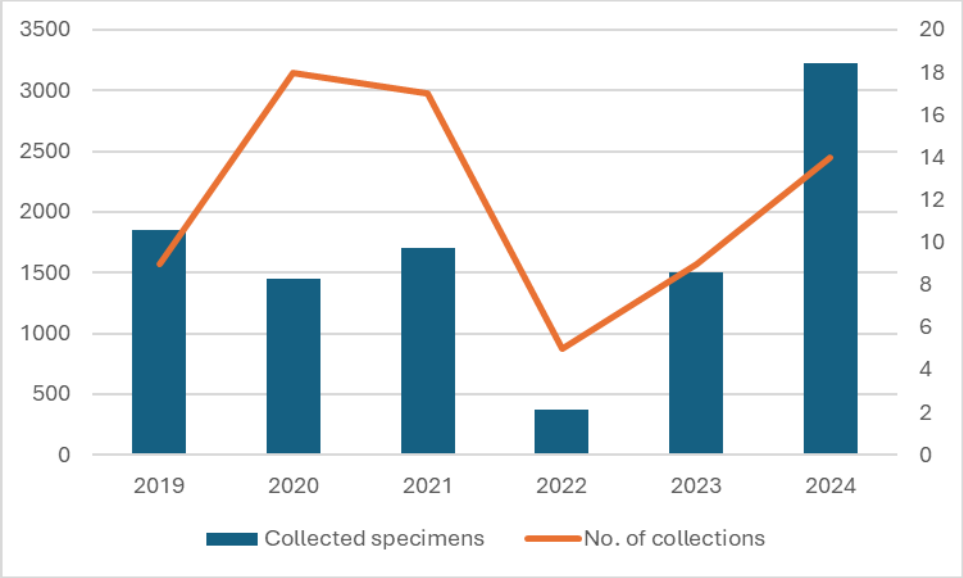
Table 1 – Frequency of scorpion (*Tityus serrulatus)* capture in cemeteries. State of São Paulo, 2019 to 2024.

Year	Nº. of municipalities	Nº. of Cemeteries			Collected specimens	Specimens / research
		Searched	Positives	%		
2019	11	103	68	66.0	18,609	273.6
2020	30	215	116	53.9	18,751	161.6
2021	28	324	183	56.5	30,368	165.9
2022	34	427	332	77.0	65,154	196.2
2023	55	566	422	74.0	108,270	256.5
2024	30	343	264	76.9	30,803	116.6
Total		1978	1385	70.0	271,955	196.3

Source: Scorpio System – SES/CCD.

When analyzing the municipality of Serra Negra, an increase in the number of scorpion specimens collected in cemeteries was observed between 2023 and 2024 (Figure 3). The year 2022 was the one in which the lowest capture rate was recorded, reflecting the impact of the COVID-19 pandemic.

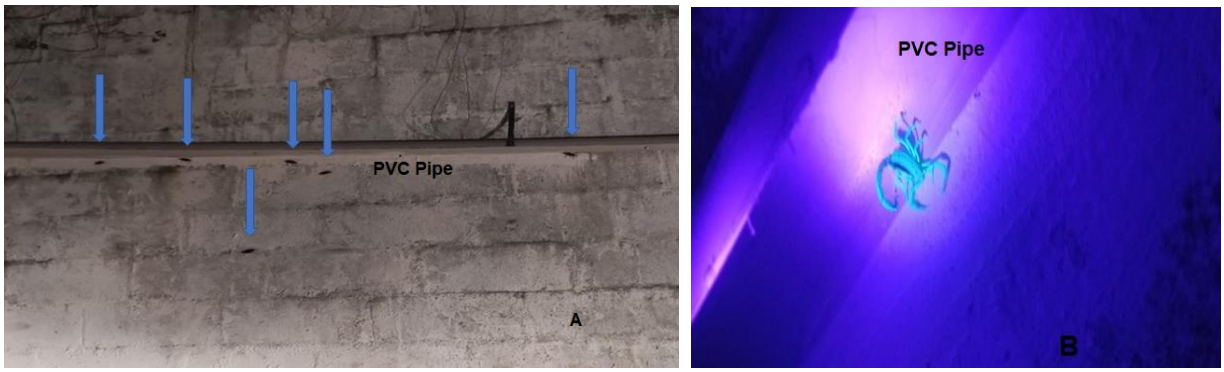
Figure 3 – Scorpion specimens collected in the cemetery of Serra Negra, Brazil, from 2019 to 2024.



Source: Scorpio System – SES/CCD.

With the installation of the mechanical barrier (inverted PVC gutter) on the inner wall of the cemetery, it was possible to verify that the scorpions and cockroaches were unable to reach the other areas. During nighttime surveys in this environment, it was observed that scorpions and cockroaches climbed the wall but did not cross the installed structure (Figure 4).

Figure 4 – PVC pipe mechanical barrier installed. (A) the arrows are indicating the cockroaches that cannot cross the barrier and; (B) a scorpion of the species *Tityus serrulatus* seen at night with the aid of a black light on the PVC pipe barrier. Serra Negra Municipal Cemetery, 2024.



Source: Author's file (2024).

In 2018, 52 cases of scorpions were found in properties near the cemetery. After the device was installed, scorpion specimens were detected by residents in properties neighboring the cemetery until 2024.

The application of chemical control aimed at targeting the cockroach population, to reduce food supply, demonstrated that these animals, as well as scorpions, are unable to cross the installed barrier, where it was possible to verify sightings of scorpions on the walls, mainly young ones, which are unable to leave the municipal cemetery premises.

The total cost of purchasing materials and installing the cemetery surroundings was R$16,156.00 (US$ 2,506.20 - December 2024 quote), for an area of 638 meters. The price per meter for installation and materials was R$25.32 (US$3.92). The most considerable amount allocated to the installation paid to the contracted company, was R$10,206.00 (US$1,583.20).

4. Discussion

Scorpions are found in practically all environments; however, the disorderly growth of urban centers has provided increasingly favorable conditions for the installation and proliferation of these animals near homes, in peri- and intra-domestic environments (Amado et al., 2021). In these environments, they find hiding places in vacant lots, old buildings, under rubble, piles of wood and bricks, and among light boxes, among others. A study conducted by Almeida et al. (2021) demonstrated an association between the percentage of households with garbage in their surroundings and the presence of scorpions.

Cemeteries are considered vulnerable areas for scorpion presence. Lisboa and Brites-Neto (2022), working with information extracted from the collection of *T. serrulatus* in the municipal cemetery of the city of Americana, São Paulo, Brazil, demonstrated the importance of this location with the abundance of scorpions. Furthermore, it was observed that the removal of specimens by manual capture throughout the period did not reflect a decrease in the occurrence of accidents.

The municipality of Serra Negra has been actively searching for scorpions in its municipal cemetery regularly, aiming to reduce the density of this animal in the environment and consequently prevent its dispersion to neighboring houses. The installation of the mechanical barrier had a direct impact on the protection of the local population, with only one scorpion

being found by residents living around the cemetery. This barrier provided security, allowing the food supply, primarily represented by cockroaches, to reduce the use of chemical control.

Despite this information, it is worth highlighting that throughout the period, there was no drop in the number of specimens collected in the cemetery of the municipality of Serra Negra, as well as in the cemeteries surveyed in the state of São Paulo. The capture of live scorpions is indisputable when referring to the production chain of anti-scorpion serum; however, we cannot overlook the severity associated with accidents, especially in children under 10 years of age in the state of São Paulo (Bhavya et al., 2016; Eloy et al., 2021).

While on the one hand, there is a recommendation not to use chemical products to control scorpions, considering their biology and behavior, on the other hand, manual collection has not been effective in reducing scorpion density and their presence in properties located in their surroundings. The installed mechanical barrier provided security to prevent the spread of this animal to neighboring environments. It is worth noting that the installation of this mechanical barrier is low-cost, easy to install, requires minimal maintenance, and has proven to be both efficient and effective. The use of chemical products to control scorpions is a controversial topic that raises a technical-scientific dilemma, highlighting the need for well-designed research studies to address knowledge gaps about this animal and its response to chemical products (Souza, 2012).

Preventive and management measures in cemeteries should be combined with actions to reduce the food supply. Therefore, maintaining regular cleaning, avoiding the accumulation of garbage and debris; sealing cracks and holes in graves and structures; controlling the insect population, which serves as food for scorpions; preventing the accumulation of stagnant water, thereby reducing humidity in suitable areas; and guiding visitors and employees on the care taken when handling objects and plants in graves, should be actions that can reflect in the reduction of infestation in this environment. Awareness and the adoption of preventive practices are crucial in reducing the presence of scorpions in cemeteries and minimizing the risk of accidents.

5. Conclusion

The installation of the inverted PVC gutter on the internal walls of the municipal cemetery represents an innovation in scorpion control, providing safety and tranquility to the surrounding residents, as both cockroaches and scorpions are unable to overcome the installed mechanical barrier.

Added to this is the low cost of installing this structure, which is feasible from a cost-benefit perspective. The results demonstrated a direct impact on the surveillance of this animal in homes. They can be incorporated into public policies and the control of infestations of this arachnid, with significant repercussions for human health.

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