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Prevention, surveillance, and scorpion accident control: an integrative review

Prevenção, vigilância e controle de acidentes com escorpiões: uma revisão integrativa

Prevención, vigilancia y control de accidentes con escorpiones: una revisión integradora

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Rafaella Orlando Guerra
ORCID: https://orcid.org/0000-0002-1645-8177
São Paulo State University, Brazil
E-mail: rafaella.guerra@unesp.br
Dreyf de Assis Gonçalves
ORCID: https://orcid.org/0000-0001-6069-6239
São Paulo State University, Brazil
E-mail: dreyf.assis@unesp.br
Bruna Moretti
ORCID: https://orcid.org/0000-0001-6022-4039
São Paulo State University, Brazil
E-mail: bruna.moretti03@yahoo.com.br
Katia Denise Saraiva Bresciani
ORCID: https://orcid.org/0000-0002-8767-8855
São Paulo State University, Brazil
E-mail: katia.bresciani@unesp.br

Abstract
There are several species of scorpions. Among these, three, *Tityus serrulatus*, *Tityus bahiensis*, and *Tityus stigmurus* are found in Brazil and present medical and veterinary importance, implying enormous challenges to the public health regarding population and environmental health. The scorpions are the main responsible for accidents among venomous animals in Brazil, being *T. serrulatus* the most dangerous species, given its wide distribution in the country, in urban centers, and the vast toxic potential of its venom. Methodology: based on this information, given the theme's importance to public health, and bibliographical scarcity, a systematic integrative review was elaborated in databases: BVS; REDALYC, and CAPES. Objective: better highlight the information in the context of prevention, surveillance, and control of scorpions in urban areas through a scientific compilation produced in the last ten years. Results: six integrative content categories were systematized on the topic. Closing remarks: scorpions had their environment devastated by anthropomorphism and adapted to the imposed urban conditions. Correct compliance with hygienic-sanitary measures and active population surveillance favors the reduction of scorpionism. Complementary, the mechanical capture corresponds to the most effective form of scorpion control. Nonetheless, chemical, and biological controls, focusing on the *Tityus genus*, especially, *T. serrulatus*, need further studies to prove their real effectiveness.
Keywords: *Tityus serrulatus*; *Tityus*; Scorpionism; Scorpion accident prevention; Scorpion accident surveillance; Scorpionic accidents control; Chemical control.

Resumo
Existem diversas espécies de escorpiões. Dentre estas, três, *Tityus serrulatus*, *Tityus bahiensis* e *Tityus stigmurus*, são encontradas no Brasil e apresentam importância em Medicina Humana e Veterinária, com implicação em enormes desafios à Saúde Pública, no que tange à saúde populacional e ambiental. Os escorpiões são os principais responsáveis por acidentes dentre os animais peçonhentos no Brasil, sendo o *T. serrulatus* a espécie mais perigosa, dado a sua ampla distribuição no país, em centros urbanos e ao grande potencial tóxico de seu veneno. Metodologia: baseado nessas informações e devido a importância do tema para a Saúde Pública e a escassez bibliográfica a respeito, foi elaborada uma revisão sistemática integrativa nas bases: BVS; REDALYC e CAPES. Objetivo: melhor evidenciar as informações no contexto da prevenção, vigilância e controle de escorpiões em âmbitos urbanos, através de uma compilação científica produzida nos últimos dez anos. Resultados: seis categorias integrativas de conteúdos foram sistematizadas sobre o tema. Considerações finais: os escorpiões tiveram seus ambientes devastados pelo antropomorfismo e se adaptaram às condições urbanas impostas. O cumprimento correto de medidas higiênico-sanitárias e a vigilância populacional ativa favorecem a diminuição do escorpionismo. De modo complementar, a captura mecânica corresponde à forma mais eficaz de controle de escorpiões. Por outro lado, os controles químico e biológico, com foco em animais do gênero *Tityus*, em especial, *T. serrulatus*, carecem de mais estudos para comprovação de suas reais eficácias.
Palavras-chave: *Tityus serrulatus*; *Tityus*; Escorpionismo; Prevenção de acidentes escorpiônicos; Vigilância de acidentes escorpiônicos; Controle de acidentes escorpiônicos; Controle químico.

Resumen
Existen diversas especies de alacranes, de los cuales tres se encuentran en Brasil y tienen importancia para la Medicina Humana y Veterinaria: *T. serrulatus*, *T. bahiensis* y *T. stigmurus*, lo que implica un gran desafío para la salud colectiva y su relación con el tema sanitario, poblacional y ambiental. Además, los escorpiones son los principales responsables por los accidentes ocasionados por animales venenosos en Brasil, siendo el *T. serrulatus* el más peligroso, dada su amplia distribución en el país, en ámbitos urbanos y el gran potencial de su veneno. Metodología: basado en estas informaciones y teniendo en cuenta la importancia de tema para la salud colectiva y la escasez bibliográfica al respecto, se propone elaborar una revisión integradora en las bases de datos: BVS, Redalyc y CAPES. Objetivo: evidenciar mejor las informaciones en el contexto de la prevención, vigilancia y control de escorpiones en ámbitos urbanos, mediante una compilación científica producida en los últimos diez años. Resultado: se sistematizaron seis categorías integradoras de contenido sobre el tema. Consideraciones finales: los escorpiones tuvieron sus ambientes devastados por acciones antropomórficas y se han adaptado a las condiciones impuestas. El cumplimiento correcto de medidas higiénico-sanitarias y la vigilancia activa de la población favorecen la reducción del escorpionismo. Complementariamente, la captura mecánica corresponde a la forma más eficaz de control de escorpiones. Por otro lado, los controles químicos o biológicos, con foco en animales del género *Tityus*, en especial, *T.serrulatus*, carecen de más estudios para comprobar sus verdaderas eficacias.
Palabras clave: *Tityus serrulatus*; *Tityus;* Escorpionismo; Prevención de accidentes escorpiónicos; Vigilancia de accidentes escorpiónicos; Control de accidentes Escorpiónicos; Control químico.

1. Introduction

There are approximately one thousand and five hundred scorpion species around the world (Nogueira, 2011; (Nencioni, et al., 2018). Three of these are found in Brazil and present importance in veterinary and human medicine. Of the *Tityus genus*: *T. serrulatus*, *T. bahiensis*, and *T. stigmurus* (Nogueira, 2011), represent a significant challenge to public health and its relation to environmental and human health. Furthermore, scorpions are mainly responsible for venomous animal accidents in Brazil (Monaco, et al., 2017).

According to the Superintendence of Endemic Control (SUCEN), there was an expressive increase in scorpionic accident numbers in Araçatuba, with a record of one thousand and seventy-nine notifications and um death in 2018. Among the scorpion species, *T. serrulatus* is the most dangerous in South America and the more worrisome, given its wide distribution in Brazil's urban centers and its venom's vast toxic potential (Shojai, 2017). Although scorpions live in solitude, environmental restrictions may favor intraspecific tolerance (Brownell & Polis, 2001).

It is important to mention that are no studies proving the effectiveness of chemicals in eliminating scorpions (BRASIL, 2016), only serving to scatter them in search of new prey, mostly cockroaches, and a new habitat to lodge, increasing the potential chances of an accident with humans, children, the elderly, and animals. Moreover, accidents are usually reported belatedly (Candido & Fan, 2019).

Based on the principles of the Systematic Review and One Health Manuals, given the above, the theme's importance, and its bibliographical scarcity, this integrative systematic review was elaborated on the prevention, surveillance, and control of *T. serrulatus* species in urban centers at Brazil, focusing on the development of prevention, surveillance, and control actions and programs, presenting them more clearly and comprehensively, to reduce the number of accidents by the venomous animal and to generate the knowledge that the scorpion is not the villain. Purpose: Scorpions are the main responsible for accidents among venomous animals in Brazil, being *T. serrulatus* the most dangerous species, given its wide distribution in the country, in urban areas, and the vast toxic potential of its venom. Based on this information, given the theme's importance to public health, and bibliographical scarcity, a systematic integrative review was elaborated to better highlight the information in the context of prevention, surveillance, and control of scorpions in urban areas through a scientific compilation produced in the last ten years.

2. Methodology

Considering the focus on the Public Health context for the present review, the principles of the Integrative Review had been adopted as a methodological resource (Brasil, 2012). The Systematic Literature Review is a research modality recommended for decision-making situations, especially in the public health context, as predicts the recommendations of the Health Ministry. In addition to national recommendations, we incorporated good practice references for review studies (Stillwell, et al., 2010; Botelho, et al., 2011).

Given this, Public Health priorities were selected, directing us to the databases and reference institutions of the BVS (Virtual Health Library), Redalyc (Network of Scientific Journals from Latin America and the Caribbean, Spain, and Portugal), and CAPES Portal, as they are the databases that represent the main focus of technical-scientific production in the context of Public Health, and are sources of official information on Public Health and social assistance policies (Brasil, 2018).

The present review was carried out with data from articles and scientific documents already published, as well as bibliographical sources in scientific virtual platforms and official surveillance and control agencies, given that review studies favor a purposeful discussion on social issues and need to be faced from the scientific principles from sources and surveys about a particular area of academic and scientific study (Brasil, 2012; Brasil, 2014; Galvão & Pereira, 2014).

Data and information from the last 10 years were used in the research, where aspects related to scorpionism were identified, beyond the classical composition of studies on accidents and stings or venom neurotoxicity, focusing the review on professional and personal performance contribution, as well as a resolution that can serve as a model for intervention in the context of health prevention and promotion.

The stages of the review process begin with terms referring to *Tityus serrulatus*, a broad context from which it was restricted to chemical control focus given its interfaces to national public health priorities (BRASIL, 2018). The chemical control descriptor is presented as a broad and diverse term, so approximately more than 1.400 articles were excluded by inclusion and duplicate criteria of texts present in more than one database. The finalization of the material sample for analysis continues to eliminate all publications without any focus on surveillance and prevention context, totalizing 18 articles for final analysis as described in Figure 1.

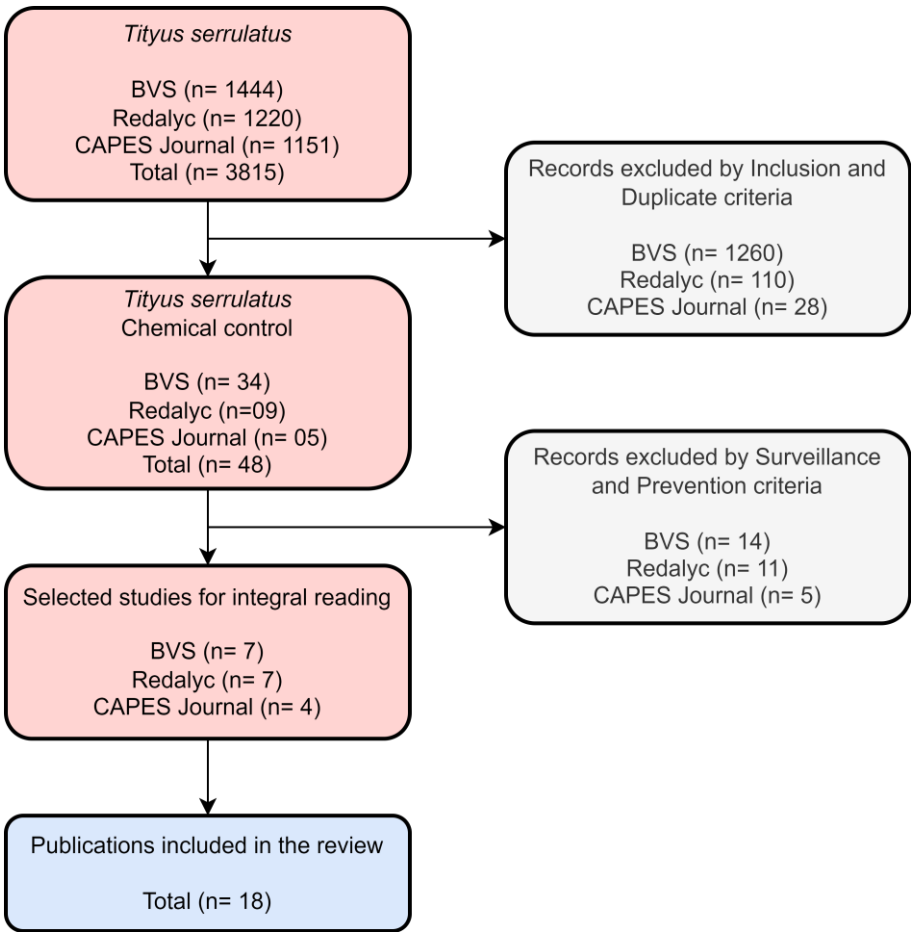
Thus, descriptive analyzes were conducted on the significant aspects pointed out by the research, and a comparison of data, research notes, and public health guidelines was conducted.

In short, it is possible to divide the study construction stages into 1) elaboration of the guiding question, 2) selection of articles and/or literary materials, 3) data collection, 4) analysis and integration of studies, 5) discussion elaboration, and 6) bibliographical review synthesis, as a methodological synthesis proposed by Galvão e Gomes. (2014).

The criteria used for inclusion of publications in the review were essentially 1) direct relation to *Tityus* genus context, 2) technical and scientific production, and 3) be accessible and free of charge in scientific databases and official sources of public policies. In front of these sources, the criterion of primary and exclusive focus was applied to the context of human health promotion and prevention and its implications and interaction risks between human health and scorpionic accidents as a priority in public health.

In Figure 1 below, the flow of research data production, in which we started from a universe of 3815 articles among the three databases, this being filtered from the chemical control descriptor as an exclusion criterion specifying the sample context for forty-eight, and of these eighteen were selected for their application in the context of health surveillance and promotion. All other articles outside this context were discarded from the analysis, which includes only documents and technical references from health authorities and official public health official agencies.

Figure 1 - Plan of research.



Source: Own Authorship.

In Chart 1 below are gathered the main analyzed products related to the thematic categories used for the total composition of the productions that composed the scope that integrates a review of official documents with scientific productions which maintains a primary focus of studies in the context of chemical control in different study modalities and which in turn evaluate at least three test substances with low or no success.

As an organizing element of the analyzed production four thematic categories were established to favor the comprehension of the scientific production chart beyond the classic “scorpionicides”: treatment and/or prevention, mechanical control, chemical control, and biological control.

Chart 1 – Scientific productions included in the integrative review.

No.	Year	Authors	Title	Analysis	Nature
01	2019	São Paulo	Uso de produto químico como escorpionicida.	• Treatmentent and/or prevention • Mechanical control • Chemical control • Biological control	Technical manual
02	2014	Souza, C. M. V.	Urban Scorpion Populations and Public Health in Brazil (G. Müller, R. Porposchil, & W. H. Robinson, Eds.). Proceedings of the Eighth International Conference on Urban Pests.	• Treatment and/or prevention • Mechanical control • Chemical control	Scientific paper
03	2009	Brasil	Manual de Controle de Escorpiões.	• Treatment and/or prevention • Mechanical control • Chemical control	Technical manual
04	2011	Ramires, E. N., Navarro-Silva, M. A., & Assis Marques, F.	Chemical Control of Spiders and Scorpions in Urban Areas. In Pesticides in the Modern World - Pests Control and Pesticides Exposure and Toxicity Assessment. InTech.	• Treatment and/or prevention • Chemical control	Scientific paper
05	2019	Brasil	DATASUS – Departamento de Informática do SUS. Sistema Nacional de Notificação de Agravos (SINAN).	Treatment and/or prevention	Information system
06	2018	Souza, L., & Vieira, C. M.	Seminário sobre Vigilância de Acidentes por Animais Peçonhentos. Instituto Vital Brazil.	Treatment and/or prevention	Scientific event
07	2019	Brasil, J, Brites-Neto, J.	Avaliação da mobilidade de escorpiões Tityus serrulatus em área de infestação urbana de Americana, São Paulo, Brasil.	Chemical control	Scientific paper
08	2018	Ward, M. J., Ellsworth, S. A., & Nystrom, G. S.	A global accounting of medically significant scorpions: Epidemiology, major toxins, and comparative resources in harmless counterparts.	Chemical control	Scientific paper
09	2017	Brites-Neto, J.	Atividade escorpionicida de metabólitos secundários de Paecilomyces formosus em bioensaios in vivo com Tityus serrulatus, Lutz e Mello, 1922 (Scorpiones: Buthidae).	Chemical control	Doctoral thesis
10	2014	Roodt, A.	Comments on Environmental and Sanitary Aspects of the Scorpionism by Tityus trivittatus in Buenos Aires City, Argentina.	Chemical control	Scientific paper
11	2013	Carvalho, G.	Avaliação da aplicação de inseticidas no controle de escorpiões Tityus serrulatus e do efeito residual dos tratamentos nas condições ambientais de Lagoa da Prata.	Chemical control	Monography
12	2009	Albuquerque, C. M. R., Barbosa, M. O., & Iannuzzi, L.	Tityus stigmurus (Thorell, 1876) (Scorpiones; Buthidae): response to chemical control and understanding of scorpionism among the population.	Chemical control	Scientific paper
13	2009	Stutz, W. H., Beneck, O., Macedo, E. M., Ciricado de Camargo, J. C., Santos Oliveira, F., & Fratari Bonito, R.	Bioensaio Visando Controle de Escorpionídeos (Tityus serrulatus), através do uso de Bendiocarb, Deltamethrin e Lambda-cyhalothrin.	Chemical control	Scientific paper
14	2006	WHO	Pesticides and their application: For de control of vectors and pests of public health importance.	Chemical control	Scientific paper
15	2002	Ramsey, J. M., Salgado, L., Cruz-Celis, A., Lopez, R., Alvear, A. L., Espinosa, L.	Domestic scorpion control with pyrethroid insecticides in Mexico. Medical and Veterinary Entomology.	Chemical control	Scientific paper
16	1995	Cruz EFS, Yassuda CRW, Jim, Barraviera B	Programa de controle de surto de escorpião Tityus serrulatus, lutz e mello 1922, no município de Aparecida, SP (Scorpiones Bbuthidae).	Chemical control	Scientific paper
17	1955	Bücherl, W.	Escorpiões e Escorpionismo no Brasil.	Chemical control	Scientific paper

18	2017	Brites-Neto, J.	Scorpionicidal activity of secondary metabolites from *Paecilomyces formosus* in vivo bioassays with *Tityus serrulatus*", Lutz e Mello, 1922 (Scorpiones: Buthidae)	Biological control	Doctoral thesis

Source: Own Authorship.

3. Development

Scorpions' origin

According to information extracted from the 2010 meeting of the program "Adopt a Scientist", USP, scorpions date back about four hundred million years. Their ancestors inhabited marine environments, leaving these just to hunt, and they measured around one meter in length. This is because in this period, denominated Carboniferous Period, there was a high concentration of oxygen in the atmosphere, between 35 to 40% versus a concentration of 20.84% nowadays, a fact connected with the size of the living beings that inhabited the planet (Brownell & Polis, 2001).

In arthropods, breathing is tracheal. The air enters through the respiratory stigmas, diffuses to the trachea, and from this directly to the cells, with no blood circulating involvement, which strengthens the body mass/oxygen ratio, since the bigger the animal the greater the difficulty getting oxygen to its destination (Brownell & Polis, 2001).

Thus, with the decrease of the oxygen concentration in the air with the passing of ages, scorpions were required to adapt to this environment, thus decreasing their respective sizes (Brownell & Polis, 2001). It is worth emphasizing that the proportion of the animal is not equivalent to the toxic potential of its venom. One of the biggest scorpion species of modernity, *Pandinus imperator*, measures about fifteen centimeters e presents less dangerousness when compared with *T. serrulatus*, a Brazilian species that measures only seven centimeters (Brownell & Polis, 2001).

Scorpions' anatomy and physiology

The scorpion is a chelicerate arthropod of the class *Arachnida*, therefore, it has an exoskeleton and its body is divided into cephalothorax and abdomen, one pair of pedipalps, one pair of chelicerae, and four pairs of legs (Monaco et al., 2017). Its appearance is quite characteristic, which allows easy identification of the animal. It is in the cephalothorax (prosome) where are the four pairs of legs, the pedipalps (capture), two to five side-eyes, and a pair of middling eyes (may be absent or poorly developed in species that inhabit light-deprived environments), and the chelicerae (shredding).

The simple eyes are sensitive to light and, therefore, important tools to scorpions since they have nocturnal habits. The abdomen (opisthosoma) is subdivided into trunk (mesosome), and tail (metasome). In the ventral portion of the mesosome are the genital operculum, and the sensory appendages, pectines (comb-like structure), and respiratory stigma. In the final portion of the metasome, there is the telson, where the two venom glands and the sting insert themselves, responsible for the venom inoculation to paralyze the prey, allowing the animal to feed and free itself from threats (Brazil & Porto, 2010; Candido & Fan, 2019).

Although the animal does not possess appendages on its abdomen, early in the pre-abdomen, in its ventral portion, the sensory appendages are found, the pectines (comb-like structure). The pectines are sensory and tactile organs, consisting of chemoreceptors, which allow the perception of the environment. Through them, the scorpions feel the vibrations of their prey since, although they have eyes, they have poor eyesight and become sensitive to chemicals dispersed in the environment (Polis, 1990 & Marcussi et al., 2011).

The animal also has a chitin exoskeleton, protecting it from excessive evaporation e allowing it to grow through ecdysis, in addition to bristles scattered throughout the body, responsible for the perception of chemical sensations, temperature, and humidity variations (Marcussi et al., 2011).

Despite morphological preservation throughout evolution, there are particularities among scorpion species. According to the Butantan Institute's Scorpion Manual, *T. serrulatus* species (commonly known as "yellow scorpion"), has this name because of its coloration, dark upper body, and the physiognomy of its tail presents a serrate shape, being very well adapted to urban areas due to their parthenogenetic reproduction, i.e., female self-fertilization, having around two births per year with about twenty to twenty-five pups each, the offspring being identical to the mother (Cologna et al., 2009; Candido & Fan, 2019). Its length can reach seven centimeters in the adult phase (Monaco et al., 2017).

T. stigmurus (Northeast yellow scorpion) has a yellowish coloration with a dark triangle located in its cephalothorax and a dark band on its back. In turn, *T. bahiensis* (brown scorpion) has a brownish coloration with flecks on the palps and legs, being able to reach seven centimeters in the adult phase (Nogueira, 2011).

The physiology of respiratory stigmas is a key point to understanding the response of scorpions to the action of scorpionicides, responsible for gas exchange, is intricately linked to the animal's sensory system, capable of blocking the passage of air when its integrity is threatened by chemicals dispersed in it, keeping it close for a long time. *T. serrulatus* is the most resistant species to scorpionicides, a condition provided by the greater sensitivity of their respiratory stigmas to air displacement (Candido & Fan, 2019).

Scorpions have the lowest metabolic rate in the animal kingdom, which effectively contributes for them to remain extended periods without food, due to the great physiological capacities of energy reserve of their hepatopancreas (Hjelle, 1990). Another reason for this is the low loss of water in the act of breathing, which was proven in an experiment to assess the survival time of scorpions without an offer of diet and/or water, where it was possible to observe that they survived up to twelve months without food or water and for three years with water but without food (Stockman, 2015).

Scorpion venom, clinical signs, and diagnosis

The scorpion venom is composed of low molecular weight protein, a small number of amino acids, and salts, presenting in its composition a toxic fraction (neurotoxin) (Nogueira, 2011), that contributed to its morphological preservation through the evolution process (Barbosa et al., 2012). The intense pain in the sting site, reported by victims of scorpion accidents, is linked to this neurotoxic characteristic of the venom (Nogueira, 2011).

The neurotoxins act on sodium and calcium channels and trigger changes in the action potentials at sympathetic and parasympathetic nerve endings, responsible for the liberation of chemical mediators, catecholamines, and acetylcholine, respectively. In addition to the acute pain at the sting site, these accidents may trigger systemic signs from sympathetic alterations, such as pulmonary edema, cardiac arrhythmias, arterial hypo or hypertension, and parasympathetic ones, such as salivation, vomiting, tremors, muscle spasms, bradycardia and miosis (Shojai, 2017).

All scorpions have hypodermic stingers at the tip of their tails, which allows them to regulate the amount of venom to be injected. In situations where the venom arsenal of these animals is emptied, the sting is not toxic, however, it generates a caustic pain at the sting site that lasts up to one hour and precedes numbness and tingling that cease after approximately twenty-four hours. In response to local pain, animals may exhibit vocalization and self-mutilation. The sting site may be non-visible or slightly edematous fifteen to thirty minutes after the scorpionic accident (Shojai, 2017).

The main cause of death from scorpionic accidents in humans, despite being rare, is cardiogenic shock, mostly in children and the elderly. Children and the elderly are the main age group at risk, as they have a lower body water arsenal, which promotes a higher concentration of circulating toxins, in addition to failing defense systems against the toxins, either because they are not fully developed or are weakened, respectively (Carmo et al., 2019).

According to COVISA (Health Surveillance Coordinator), the diagnosis of scorpionic accidents is based on clinical-epidemiological history. It is important to note that laboratory resources are not used to confirm the type of circulating venom.

In addition, there is parity of clinical signs presented in accidents caused by spiders of the genus *Phoneutria* and scorpions of the genus *Tityus* and in these cases the stipulated treatment will be the same (BRASIL, 2001).

Scorpion reproduction

There are literary divergences regarding the parthenogenetic behavior of the animal. The Butantan Institute mentions in its manual on scorpions that of the species cited in this paper's introduction, of medical and veterinary importance, only *T. serrulatus* and *T. stigmurus* have parthenogenetic reproduction, while for Matthiesen (1961), Knox (1997), and Cologna et al. (2009) all species reproduce this way, being a competitive advantage over other animals considering the existence of sexual species.

Scorpions' predators and diet

Scorpions feed on spiders, termites, cockroaches, and other insects. Its predators include frogs, chickens, and hawks. Other natural predators of these animals can also be found in literature, such as monkeys, seriemas, lizards, mice, and, particularly, owls and Rufous Hornero, animals with nocturnal habits such as scorpions (Lima, 2014; Neoncini, 2018).

Recent research reinforces the importance of frogs to scorpion control, particularly, the cane toad (*Rhinella icterica*), since they devour venomous animals with ease, being unscathed by the venom, this fact was confirmed by experiments where large doses of venom were administered to the amphibians, consistent with ten scorpions, and suffered nothing from it, unlike rodents who were killed under the same dose. In the end, to prove the amphibians' well-being, cockroaches were offered as sources of stimulation for these animals, and all responded positively to them (Jared et al., 2020).

Scorpionism cases should be seen not only from the medical point of view but also from the biological and ecological point of view. The ecological role of the cane toad must be reinforced, but its breeding is not recommended since its exacerbated reproduction may trigger environmental unbalance. The preservation of the animal is recommended, as well as the construction of ecological corridors and passages, since due to prejudice and growing urbanization the frogs would have obstacles and would be prevented or with difficulty accessing rivers, lakes, or concentrations of water to reproduce (Jared et al., 2020).

Epidemiology of scorpions

The increase in scorpion attack numbers is related to the Atlantic Forest devastation and urbanization of the area, with the movement of the scorpions following that of human beings (Vieira, 2018).

The accidents by the animal occur more frequently in regions of tropical and subtropical climates, despite their global character (except in Antarctica) (Nogueira, 2011).

For theorists Melvin Webber and Horst Rittel, the occurrence of scorpions in urban areas in Brazil is linked to both natural causes and anthropomorphic causes, resulting from the accumulation of garbage, inadequate sanitary conditions, quick urbanization e climate changes, which they call "wicked problem" (Rittel & Webber, 1973).

In Brazil, of the ninety thousand scorpion accidents that occurred in 2018, forty thousand of those occurred in the southeast, according to data provided by the Ministry of Health.

T. serrulatus is the species responsible for most accidents in this region. The georeferencing of the species in Brazil includes the states of Minas Gerais, Bahia, Espírito Santo, Rio de Janeiro, São Paulo, Distrito Federal, Goiás, and Paraná, occurring synchronously with the species T. *stigmurus* and with T. *bahiensis*, being that T. *bahiensis* is the one that causes most accidents in the state of São Paulo (Nogueira, 2011).

According to information extracted from the 2010 meeting of the "Adopt a Scientist" program, USP, *T. serrulatus* is responsible for most accidents (about 94% of cases) in the city of Ribeirão Preto, located in the interior of São Paulo. In 1999 the fight against the accumulation of garbage and debris began, to end the outbreaks of proliferation foci of the dengue transmitting mosquito (*Aedes Aegypti*) in the region and, consequently, it was possible to notice that these actions influenced the number of scorpions, since these places are suitable for their accommodation, as a form of hiding.

In the same meeting, it is also added that between the period October and December it is common to have an increase in the number of cases of accidents by scorpions, as it is a hot and humid season, resulting from a rainy period of the year, making the environment favorable for the reproduction of the arthropods. In this period there is also an increase in the number is insects, one of its prey, therefore, there is a considerable increase in the number of scorpions.

Conduct in cases of scorpion accidents

The indication is that if a companion animal, dog, or cat, suffers a scorpion accident, it is forwarded immediately to the veterinarian, the first aid being to relieve discomfort, pain and preserve the animal's life so that it can arrive in time at the medical clinic (Shojai, 2017).

First aid includes restriction of movement, with the placement of the injured animal in a transport box to make it impossible to walk and jump and limit the venom from spreading and circulating through the animal's bloody faster; use of an Elizabethan collar to prevent self-mutilation and aggravation of the local reaction to stinging; placing a soothing sodium bicarbonate plaster over the sting site for pain relief, made from a tablespoon of sodium bicarbonate in enough water to form a thick paste, and applying on the edema, if there is one, always remembering to pass the past directly to the skin to greater effectiveness of the plaster; administration of an antihistamine, since the scorpion venom contains histamine, for pain relief and inflammation control (Shojai, 2017).

In the absence of anti-scorpion serum for companion animals, prazosin hydrochloride, an alpha-blocker, is considered a "pharmacological antidote" in scorpion intoxication, as it has alpha-1 antagonist action with reduction of total peripheric vascular resistance and cardiac filling pressure, which results in improved venous return.

According to the Health Surveillance Coordination, most cases involving scorpion accidents culminate in mild and local conditions in human beings, therefore, the use of anti-scorpion venom serum (AScVS) or anti-arachidic venom serum (SAA) is not indicated, the latter being used when the first is not available. It is important to remember that the effectiveness of both serums is the same, despite the low frequency of events it is possible that components present in the serums cause hypersensitivity reactions in victims, and therefore, people who have been subjected to this application should be under clinical observation for six hours and star symptomatic treatment for pain (use of analgesics, hot compresses, and local anesthetic blockage).

Also, according to COVISA, mild and severe cases of scorpionism are more common in children stung by *T. serrulatus*, totaling 8 to 10% of cases according to the Health Ministry, and require rapid care and intravenous administration (IV) of AScVC and SAA serum (trivalent: *Loxosceles*, *Phoneutria*, and *Tityus*) in an attempt to neutralize the circulating venom. It is reported that local symptoms are faster to disappear with specific serotherapy to the detriment of systemic manifestations.

According to Informative Note nº twenty-five, of July 19, 2016, CGDT/DEVIT/SVS/MS exposed by COVISA, confirmed cases of scorpionism with moderate clinical signs of envenomation include intense pain and systemic manifestations, where the uses of AScVC or SAA are recommended in a total of three ampoules (IV), hospitalization and systematic treatment. In severe cases where all signs mentioned above are presented with the addition of one or more exacerbated manifestations, the indicated protocol is AScVC or SAA, in the soum of six ampoules (IV), hospitalization,

continuous monitoring, and symptomatic treatment. Patients are then continuously reassessed, with initial treatment of complications, clinical reclassification, and supplementation of the treatment, and if the treatment is effective the patient can be discharged.

Asymptomatic patients with confirmed or probable scorpion accidents should be observed for a least four hours, and, if there is no clinical evolution, may be discharged, otherwise must be evaluated, and determined the best type of treatment according to the current situation.

Despite the existence of documentation, protocols, and inputs to the chemoprophylaxis process for scorpion accidents that are well documented in the context of Human Health, a gap is perceived for cases with companion or production animals, and this is aggravated as there is no existence of an anti-scorpion serum specifically for the different contexts of animal health, the treatment being strictly symptomatic (Nogueira, 2011).

The specificity of the animal health condition in the face of a scorpion accident, as well as its severity, especially in companion animals, depends on factors such as plasmatic concentration of the venom, the predominance of the effects, whether linked to the actions of acetylcholine or adrenaline and the individual sensibility of each animal (Nogueira, 2011).

4. Results and discussion

4.1 Scorpion prevention and control

4.1.1 Epidemiological surveillance

The compulsory notification of accident cases, even suspected ones, is recommended for the epidemiological surveillance of scorpions and other venomous animals to control them, in addition to assigning the most appropriate treatment to the ill according to the type of condition presented.

It is up to the population service the active surveillance function so that the collection of information by the services of the epidemiological inspection agencies is possible, and thus allow them to conduct environmental investigations for the recognition and control of these animals and/or suspected or confirmed cases.

The nearest Zoonosis Surveillance Division (ZSD) should be the first option of contact in cases of animal visualization in households and peri domiciliary regimes so that due precautions are taken.

However, according to the Health Ministry in accident cases care should be south at the nearest Health Surveillance Unit (HSU) (BHU, health center, and hospital) – see the site: http://buscasaude.prefeitura.spp.gov.br.

The HSU service is also responsible for collecting data relating to the infection site. If the capture of the animal is possible, it must be referred by the ill to the service place to facilitate the diagnosis.

4.1.2 Natural predators

In a Technical-Scientific Note, SUCEN (2019), reinforces that the raising of chickens in peri domiciliary environments has been a worrisome scorpion control strategy, recurrent in upstate cities. Worrisome because in addition to chickens having diurnal habits while scorpions have nocturnal habits (the meetings would be occasional) they create an enabling environment for sandflies breeding, and, consequently, increase in Visceral Leishmaniasis's disseminations duo to the organic vestiges generated by these animals, corroborating with Carvalho et al. (2000).

This fact is not a negative to the importance of natural predators, which are fundamental to the environmental balance, with each animal occupying its space in the food chain, being recommended and reinforced, therefore, not to eliminate them, if they are already in the place where there are scorpions (SUCEN, 2019). Corroborating this information, on its official page, O Liberal Regional, alerts to the importance of frogs as natural predators of scorpions, and, therefore, their elimination may lead to a significant increase in the number of local scorpions.

4.1.3 Prevention methods of scorpionic accidents

Scorpion accident prevention methods consist of strategies to prevent the occurrence and proliferation of scorpions, based on their habits, habitat, and diet. Hygienic-sanitary measures, environmental management, and the active search of these animals by specialized professionals are recommended.

Considering the high incidence of scorpionic accidents in Brazilian urban regions, the population must be provided with information about preventive, control, and health behaviors so that these can be assimilated into people's routines and the number of cases of scorpionism decrease in the country.

With this in mind, according to the Health Ministry, the main hygienic-sanitary and environmental control measures are presented below:

- Netting windows, doors, grease traps, and openings of drains, sinks, tanks, and power and telephone points, so that they are completely sealed to prevent the passage of scorpions, and cockroaches.
- Plaster walls, openings, and crevices so that they do not serve as scorpions' lodges.
- Seal doors sills with sand or rubber rollers to prevent scorpions from entering the home.
- Keep the internal and external parts of the house clean, to avoid the accumulation of organic matter and household waste that function as foci of attraction for scorpions' most common prey, cockroaches.
- Household waste must be well sealed in plastic bags or other properly sealed recipients and delivered on the correct day to the collection service.
- Avoid accumulation of debris, such as building materials and firewood, which can serve as a lodge for scorpions.
- Preserve scorpions' and cockroaches' natural predators such as owls, geckos, and frogs.
- Inspect and shake before using shoes, clothes, towels, bedding, floor cloths, and rugs, to avoid surprise contact with the animal.

4.1.4 Mechanical capture of scorpions

The mechanical capture corresponds to the manual collection method. In the case of scorpions, this process may derive from the apprehension of only one specimen, or in the active search for them in priority areas, of dead and alive animals, being sent and duly identified by municipal agencies, such as the Zoonosis Control Centers (ZCC), anti-scorpion serum production institutes (live animals), and research institutes, such as universities and zoos.

According to the 2020 scorpion prevention and control textbook by SUCEN, in cases of infestations, the recommendation is that the capture is carried out by professionals from the local city hall or the private network since they have safety equipment and capture tools. It is essential to bear in mind that chemical control of scorpions is not recommended by the Health Ministry as there is no scientific evidence for this, being a resource with temporary effects, favoring the displacement of these animals and increasing the risk of accidents.

If the capture is carried out on its own, in the event of a single specimen, it must be carried out with great caution since the animal can move very quickly during the escape, being able to cause accidents and/or find new lodges, this way is essential to have one more person at the scene to assist in the case of an accident during the capture.

Thus, the animal can be captured without the use of tweezers "placing a deep plastic bottle over them, sliding a thick paper, such as cardboard or paperboard, enclosing the animal in the container. When the scorpion is at the bottom and there is no risk of escape, quickly remove the paper and close the bottle with the lid. If you have long tweezers, over thirty centimeters, you can catch the scorpion with it, holding it by the tail, without exerting too much pressure. Then put it in a smooth surface plastic jar. If you are unable to collect the animal, you might exterminate it with mechanical action (slipper/blow), always

taking care of the distance of your hand from the animal. If you manage to capture it, sent the plastic bottle with the alive or dead animal to a Zoonosis Surveillance Unity of your city, City Hall, or nearest Basic Health Unit" (SUCEN, 2020, p.31-33).

According to the Health Ministry, it is important to remember that, usually, when a single specimen of a scorpion is found, in urban or peri domiciliary areas, it is likely that there are more of them on the site, because, even with solitary habits, with the intense process of urbanization scorpions began to concentrate in areas with easier access to prey and lodging.

According to SUCEN (2020, p.28-30) for the active search, the specialized team must make use of the appropriate safety equipment: vaquette or leather gloves, tweezers, long boots, long sleeves shirt, and long pants, both with cuffs of adjusted an elastic band/string/masking tape, to prevent the animal from encountering the individual's skin and stinging it. It is also necessary to have plastic bottles with a depth of more than eight centimeters and with a smooth internal surface and lid, screwed, if possible, available. Glass jars should be avoided, as they may break, causing the scorpions to escape from the containers. To keep scorpions alive, it is necessary that the container lid is pierced and that there is cotton moistened with water inside it.

It is worth noting that the mechanical capture is an extremely laborious process:

> for the technicians and managers who, in the face of large infestations, end up using or allowing the use of chemicals, even despite the current policy of scorpion control, implemented in 2009, because often the work becomes insufficient since the contribution of the population does not always occur regarding the surveillance and correct environmental management of waste and disposal of household waste, to decrease the amount of prey offered to scorpions. (SUCEN, 2019, p.1).

4.1.5 Chemical control of scorpions

The chemical control corresponds to the method in which chemical products are used to stop the advance of scorpions. In Mexico and some parts of North America, the use of pyrethroids is standardized as a populational control method and is efficient in combating scorpions of the genus *Centruroides spp*. However, for the Latin-American species of the genus *Tityus*, the mechanical capture is the most effective method of control since they have greater resistance to insecticides, a condition provided by the greater sensibility of their stigmas to air displacement.

Corroborating to substantiate those exposed above, from 11 selected bibliographic sources on the topic of scorpionicides, 8 (Souza, 2014; Roodt, 2014; Carvalho, 2013; Ramires et al., 2011; Stutz et al., 2009; Albuquerque, 2009; World Health Organization, 2006) stated that there were harmful effects on living beings, environment and/or displacement of scorpions.

The most tested active principles for chemical control of scorpions in these studies were: bendiocarb, lambda-cyhalothrin, and deltamethrin.

The effectiveness of the scorpionicides lambda-cyhalothrin, bendiocarb, and deltamethrin are diminished with the progression of time, and their chemical components cause adverse effects on the health of other animals. Among the insecticides, the one entitled bendiocarb showed lower rates of these effects (Stutz et al., 2009).

Carvalho (2013) demonstrated under laboratory conditions that the chemicals K-Othrine® 2P and Demand 10CS obtained positive evaluations in the control of *T. serrulatus*. K-Othrine® 2P proved to be effective at the beginning of the application, obtaining a high mortality rate (90%) but its residual effect decreased over time (104 days), proving ineffective after this period. Demand 10CS, solo use, obtained a 100% mortality rate of scorpions present in hiding places in a controlled environment and miniature urban centers, and its residual effect remained in place for approximately 104 days. Finally, the convergence of results in real dimensions is inconclusive and warns about the need for more studies, therefore, to evaluate their

effectiveness and effects on human, animal, and environmental health.

In its bioassay with lambda-cyhalothrin CS 10%, it showed that in a crack between bricks created for the study, the scorpion effect was effective, due to intense contact with the product. Corroborating with Carvalho's conclusion that there is still a need for more studies to prove the efficacy, residual, and adverse effects of a field study (Souza, 2014).

The household fumigation of chemicals in real dimensions may cause harm to human and animal health. It also reports the non-existence of studies on the subject for the control of *T. trivittatus* scorpions, and few for other species (Roodt, 2014).

A field study was conducted to verify the interaction of Demand 2.5 concentrates sprayed on open air in district III of Recife, in internal areas of households with constant infestations, around buildings, and in rubble and sewers. It was possible to verify the non-occurrence of scorpions on the first day and low mortality rates, combined with a greater appearance of these during the first seven days (Albuquerque, 2009).

Some reports provide proof of the effectiveness of certain chemicals when applied directly to the animal and in high dosages, different from those commercially entitled (Stutz, 2009; Carvalho, 2013; Souza, 2014). According to the Health Surveillance Secretariat, 2009, used products based on formaldehyde, cresols, and perchlorobenzene, commonly used for household cleaning, as well as insecticides, roach killers, rodenticides, or repellents based on pyrethroids, and organophosphates, are not recommended to scorpion control, given their palliative and eviction effects, revealing the false sense of protection by the residents who believe that the misfortune was solved, starting to neglect the correct environmental management.

4.1.6 Biological control of scorpions

It consists of scorpion control using biological agents, as an alternative to chemical control with a safety margin and speculated non-dislodging effects, unlike the latter.

In the Brites-Neto study entitled "Scorpionicidal activity of secondary metabolites from *Paecilomyces formosus* in vivo bioassays with *Tityus serrulatus*", Lutz and Mello, 1922 (Scorpiones: Buthidae)", the possibility of analyzing the effectiveness of the biological control of *T. serrulatus* specimens from its interaction with filamentous fungi from the same habitat, in a bioassay carried out in tombs of urban cemeteries with infestations of these scorpions is mentioned (Lutz & Mello, 1992; Bortoluzzi et al., 2007).

The results indicate that the isolated fungi with scorpionicidal activity are *Fusarium* spp., *Rhizopus* spp., and *Paecilomyces* spp., with emphasis on the latter. The fungi that presented the greatest contribution to the repellency of the specimen were *Mucos* spp. and *Phialophora* spp.

5. Final Considerations

Based on the information given throughout this review, it was concluded that the correct environmental management (hygienic-sanitary) allied to active populational surveillance, and the execution of household protection measures, such as netting doors, windows, and plumbing and piping openings, are the most efficient methods of prevention of scorpionic accidents and are configured as fundamental initial practices.

Complementary, the mechanical capture corresponds to the most effective way of scorpion control, with an emphasis in Brazil on those of the *Tityus* genus, especially, *T. serrulatus*, the species with the widest distribution in Brazil and urban centers. This does not prove to be difficult when there is the correct environmental management and active populational surveillance. On the other hand, the biological and chemical control, focusing on scorpions of the genus *Tityus*, needs further studies to prove their real effectiveness, especially in the context of research on natural components of low or no

environmental, animal, or human impact and that represent important trends in scientific knowledge production needs.

It is worth highlighting that scorpions had their environments devastated and that they adapted to imposed urban conditions, due to their physiological dynamics, habits, and genetic framework, they should not be considered villains and that with the correct orientations the probability is that the number of scorpionic accidents decreases significantly.

There are no environmental studies or compilation of data and consistent information for planning actions and interventions in public policies. The context of scorpion research is a promising field of research, especially regarding the need to compile data and information on accidents, existing important gaps in research in the context of prevention and action assessment, as of primary actions, in the context of surveillance and control information systems.

References

Albuquerque, C. M. R., Barbosa, M. O., & Iannuzzi, L. (2009, June). *Tityus stigmurus* (Thorell, 1876) (Scorpiones; Buthidae): response to chemical control and understanding of scorpionism among the population. Revista Da Sociedade Brasileira de Medicina Tropical, 42(3), 255–259.

Barbosa, A. D., Magalhães, D. F., Silva, J. A., Silva, M. X., Cardoso, M. de F. E. C., Menes, J. N. C., & Cunha, M. da C. M. (2012). Caracterização dos acidentes escorpiônicos em Belo Horizonte, Minas Gerais, Brasil, 2005 a 2009. 1785–1789.

Bortoluzzi, L. R., Querol, M. V. M., & Querol, E. (2007). Notas sobre a ocorrência de *Tityus serrulatus* Lutz & Mello, 1922 (Scorpiones, Buthidae) no oeste do Rio Grande do Sul, Brasil. http://www.biotaneotropica.org.br/v7n3/pt/abstract?article+bn00707032007

Botelho, L. L. R., Cunha, C. C. de A., & Macedo, M. (2011). O método da revisão integrativa nos estudos organizacionais. *Gestão E Sociedade*, *5*(11), 121–136. https://doi.org/10.21171/ges.v5i11.1220

Brasil. (2009). Manual de Controle de Escorpiões. www.saude.gov.br/bvsdisquesaúde:0800.61.1997

Brasil. (2012). Diretrizes metodológicas: elaboração de revisão sistemática e metanálise de ensaios clínicos randomizados. Ministério da Saúde. Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Departamento de Ciência e Tecnologia. http://www.saude.gov.br/bvs

Brasil. (2014). Diretrizes metodológicas: elaboração de revisão sistemática e metanálise de estudos observacionais comparativos sobre fatores de risco e prognóstico. Ministério da Saúde. Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Departamento de Ciência e Tecnologia. www.saude.gov.br

Brasil. (2016). Vigilância, Prevenção e Controle de Zoonoses. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. http://editora.saude.gov.br

Brazil, T. K., & Porto, T. J. (2010). *Os escorpiões*. Salvador: EDUFBA. https://repositorio.ufba.br/handle/ri/5109.

Brites-Neto, J. (2017). Atividade escorpionicida de metabólitos secundários de *Paecilomyces formosus* em bioensaios in vivo com *Tityus serrulatus*, Lutz e Mello, 1922 (Scorpiones: Buthidae) [Tese (Doutorado)]. Universidade de São Paulo.

Brites-Neto, J. (2019, August 3). Aspectos clínicos e terapêuticos do envenenamento por escorpiões em cães e gatos. Revista de Ciência Veterinária e Saúde Pública, 6(2), 442–471. https://doi.org/10.4025/revcivet.v6i2.46911

Brites-Neto, J., & Galassi, G. G. (2012, January). Monitoramento epidemiológico de *Tityus serrulatus* em áreas urbanas. Revista Vetores & Pragas, 16–17. https://www.researchgate.net/publication/258423140

Brownell, P., & Polis, G. A. (2001). *Scorpion biology and research*. Oxford: Oxford University Press.

Candido, D. M., & Fan, H. W. (2019). *Controle de escorpiões de importância em saúde*. Instituto Butantan.

Carlo Gorinchteyn, J., Boulos Diretoria de Combate Vetores Diretora da DCV Susy Mary Perpétuo Sampaio, M., & Aparecida Sanches Bersusa Colaboradores Antônio Henrique Alves Gomes Cláudia Barleta Gisele de Souza Cabral Morais Rubens Antonio Silva Sílvio Carvalho da Silva Susy Mary Perpétuo Sampaio, A. (2020). Escorpião: prevenção e controle - orientações de manejo e controle de escorpiões para síndicos de condomínios e ou conjuntos habitacionais. https://docs.bvsalud.org/biblioref/2020/10/1121755/cartilha_sindicos_de_condominios.pdf

Carmo, E. A., Nery, A. A., Pereira, R., Rios, M. A., & Casotti, C. A. (2019). Factors associated with the severity of scorpion poisoning. Texto & Contexto - Enfermagem, 28. https://doi.org/10.1590/1980-265x-tce-2017-0561

Carvalho, G. (2013). Avaliação da aplicação de inseticidas no controle de escorpiões *Tityus serrulatus* e do efeito residual dos tratamentos nas condições ambientais de Lagoa da Prata – Minas Gerais [Monografia]. Universidade Estadual Paulista "Júlio de Mesquita Filho."

Cologna, C., Marcussi, S., Giglio, J., Soares, A., & Arantes, E. (2009). *Tityus serrulatus* Scorpion Venom and Toxins: An Overview. Protein & Peptide Letters, 16(8), 920–932. https://doi.org/10.2174/092986609788923329

de Roodt, A. (2014). Comments on Environmental and Sanitary Aspects of the Scorpionism by *Tityus trivittatus* in Buenos Aires City, Argentina. Toxins, 6(4), 1434–1452. https://doi.org/10.3390/toxins6041434

Galvão, T. F., & Pereira, M. G. (2014). Revisões sistemáticas da literatura: passos para sua elaboração. *Epidemiologia e Serviços de Saúde*, *23*(1), 183-184. http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742014000100018&lng=pt&tlng=pt.

Hjelle, J. T. (1990). The Biology of Scorpions. In G. A. Polis (Ed.), The Biology of Scorpions (pp. 9–63). Stanford University.

Jared, C., Alexandre, C., Mailho-Fontana, P. L., Pimenta, D. C., Brodie, E. D., & Antoniazzi, M. M. (2020). Toads prey upon scorpions and are resistant to their venom: A biological and ecological approach to scorpionism. Toxicon, 178, 4–7. https://doi.org/10.1016/j.toxicon.2020.02.013

Knox, M. B. (1997). Estudo dos escorpiões em ambientes naturais e urbanos do DF: abordagem ecológica de duas espécies *Tityus fascicolatus* Pessôa, 1935 e *Tityus serrulatus* Lutz e Melo, 1922 (Dissertação de Mestrado). Universidade de Brasília, Brasília, DF.

Lima, M. C. J. de S., Bitencourt, M. A. O., Furtado, A. A., Oliveira Rocha, H. A., Oliveira, R. M., Silva-Júnior, A. A. da, Tabosa do Egito, E. S., Tambourgi, D. V., Zucolotto, S. M., & Fernandes-Pedrosa, M. de F. (2014). *Ipomoea asarifolia* neutralizes inflammation induced by *Tityus serrulatus* scorpion venom. Journal of Ethnopharmacology, 153(3), 890–895. https://doi.org/10.1016/j.jep.2014.03.060

Marcussi, S., Arantes, E. C., Soares, A. M., Giglio, J. R., & Mazzi, M. V. (2011). Biologia dos Escorpiões. In A. M. Soares (Ed.), Escorpiões: Biologia, Envenenamento e Mecanismos de Ação de suas Toxinas (1st ed., Vol. 1). Fundação de Pesquisas Científicas de Ribeirão Preto (FUNPEC-RP).

Matthiesen, F. A. (1961). Nota sobre escorpiões. Revista Da Agricultura, 36(3), 139–147.

Monaco, L. M., Meireles, F. C., & Abdullatif, M. T. G. V. (2017). Animais venenosos: serpentes, anfíbios, aranhas, escorpiões, insetos e lacraias. Instituto Butantan, 19–22.

Nencioni, A., Neto, E. B., de Freitas, L. A., & Dorce, V. (2018). Effects of Brazilian scorpion venoms on the central nervous system. *The journal of venomous animals and toxins including tropical diseases*, *24*, 3. Recuperado de https://doi.org/10.1186/s40409-018-0139-x

Nogueira, R. M. B., & Andrade, S. F. (2011). Toxicologia Veterinária (Roca).

Polis, G. A. (1990). The Biology of Scorpions. Stanford University Press.

Polis, G. A., & Sissom, W. D. (1990). Life history. In Polis, G. A. (Ed.), The Biology of Scorpions (pp. 161-223). Stanford University.

Ramires, E. N., Navarro-Silva, M. A., & Assis Marques, F. (2011). Chemical Control of Spiders and Scorpions in Urban Areas. In Pesticides in the Modern World - Pests Control and Pesticides Exposure and Toxicity Assessment. InTech. https://doi.org/10.5772/16562

Rittel, H. W. J., & Webber, M. M. (1973, June). Dilemmas in a General Theory of Planning. Policy Sciences, 155–169.

Shojai, A. D. (2017). Primeiros Socorros de Cães e Gatos (E. Nazarian, Ed.; (3rd ed.). Guttenberg.

Souza, C. M. V. (2014). Urban Scorpion Populations and Public Health in Brazil (G. Müller, R. Porpischil, & W. H. Robinson, Eds.). Proceedings of the Eighth International Conference on Urban Pests. https://www.cabdirect.org/cabdirect/abstract/20153376195

Souza, L., & Vieira, C. M. (2018). Seminário sobre Vigilância de Acidentes por Animais Peçonhentos. Instituto Vital Brazil.

Stillwell, S. B., Fineout-Overholt, E., Melnyk, B. M., & Williamson, K. M. (2010). Evidence-based practice, step by step: searching for the evidence. *The American journal of nursing*, *110*(5), 41–47. https://doi.org/10.1097/01.NAJ.0000372071.24134.7e

Stockmann, R. (2015). Introduction to Scorpion Biology and Ecology. In Scorpion Venoms (pp. 25–59). Springer Netherlands. https://doi.org/10.1007/978-94-007-6404-0_14

Stutz, W. H., Beneck, O., Macedo, E. M., Ciricado de Camargo, J. C., Santos Oliveira, F., & Fratari Bonito, R. (2009, October). Bioensaio Visando Controle de Escorpionídeos (*Tityus serrulatus*), através do uso de Bendiocarb, Deltamethrin e Lambda-cyhalothrin. http://www.oocities.org/whstutz/bioensaio.html
Sucen. (2019). Uso de produto químico como escorpionicida.

Ward, M. J., Ellsworth, S. A., & Nystrom, G. S. (2018). A global accounting of medically significant scorpions: Epidemiology, major toxins, and comparative resources in harmless counterparts. Toxicon, 151, 137–155. https://doi.org/10.1016/J.TOXICON.2018.07.007

World Health Organization. (2006). Pesticides and their application: for de control of vectors and pests of public health importance. 3(114p).