

# Venomous and poisonous arthropods: identification, clinical manifestations of envenomation, and treatments used in human injuries

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## ABSTRACT

This review presents the main species of venomous and poisonous arthropods, with commentary on the clinical manifestations provoked by the toxins and therapeutic measures used to treat human envenomations. The groups of arthropods discussed include the class Arachnida (spiders and scorpions, which are responsible for many injuries reported worldwide, including Brazil); the subphylum Myriapoda, with the classes Chilopoda and Diplopoda (centipedes and millipedes); and the subphylum Hexapoda, with the class Insecta and the orders Coleoptera (beetles), Hemiptera (stink bugs, giant water bugs, and cicadas), Hymenoptera (ants, wasps, and bees), and Lepidoptera (butterflies and moths).

**Keywords:** Bites and stings. Venomous animals. Venomous arthropods. Poisonous arthropods.

## INTRODUCTION

Arthropods belong to the invertebrate Phylum Arthropoda. The name arthropod comes from the Greek *arthron* meaning joint and *pod*, meaning foot, which is one of their characteristic features. They also have an external *skeleton*, or exoskeleton, made of chitin. The Arthropoda phylum contains the most species on Earth, mainly due the number of animals in the Insecta Class<sup>(1) (2) (3) (4) (5) (6)</sup>.

Arthropod species use toxins for defense and to kill prey. Some individuals are poisonous (e.g., certain beetles release toxins when pressed or crushed), whereas others inject venom using an apparatus, which can cause systemic repercussions in the prey, as observed with the stings of certain spiders and scorpions<sup>(3) (4) (5) (6)</sup>.

The classification of arthropods uses subphyla, classes, and orders. The subphylum Chelicerata and class Arachnida includes spiders and scorpions, which are responsible for the most human injuries worldwide. In the subphylum Myriapoda, the classes Chilopoda and Diplopoda (centipedes and millipedes) also cause human harm. The subphylum Hexapoda includes the class Insecta, with both poisonous and venomous representatives, especially in the orders Coleoptera (beetles), Hemiptera (stink

bugs, giant water bugs, and cicadas), Hymenoptera (ants, wasps, and bees), and Lepidoptera (butterflies and moths)<sup>(1) (2)</sup> (**Table 1**).

The Health Ministry notification system focuses on human injuries caused by snakes, spiders, and scorpions because of the risk of systemic complications and death, but the most common envenomations are likely caused by caterpillars, ants, and bees<sup>(5) (6)</sup>.

## SUBPHYLUM CHELICERATA

### Class Arachnida

Among the venomous animals, spiders and scorpions are responsible for the most envenomations in Brazil (**Figure 1**).

**Spiders.** The main species of spiders associated with severe envenomation are: 1) Australian funnel web spiders: these large, aggressive spiders are found in Australia and belong to the genera *Atrax*, *Hadronyche*, and *Illawarra*. The venom is toxic to sodium channels, which results in the massive release of neurotransmitters. Envenomation can lead to arterial hypertension/hypotension, pulmonary edema, intracranial hypertension, and death. Envenomation can be treated with specific antiserum. 2) *Armadeiras*, banana spiders, or Brazilian wandering spiders: These large, extremely aggressive spiders sometimes attack without provocation and can leap up to 20cm on the victim. These *armadeiras* assume an attack position before biting. The spiders are common and the most important species is *Phoneutria nigriventer* (*Phoneutria* means *killer in Ancient Greek*). According to Health Ministry data, banana spiders rank second among spiders causing injuries in Brazil. Manifestations of envenomation are similar to those of the funnel web spider, including alternating symptoms of neurological

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**TABLE 1 - Zoological classification of the venomous and poisonous arthropods.**

Poisonous and venomous arthropods
Subphylum Chelicerata
Class Arachnida: spiders and scorpions
Subphylum Myriapoda
Classes Chilopoda and Diplopoda: centipedes and millipedes
Subphylum Hexapoda
Class Insecta

origin and arterial hypertension resulting from toxic action on sodium channels and the release of neurotransmitters. Children and debilitated individuals are at higher risk of death. Bites often occur in households because of the wandering nature of the spider as it seeks prey (especially cockroaches). The pain resulting from a bite is excruciating and there is discrete inflammation at the site of envenomation. Affected individuals may present with hypertension, nausea, vomiting, priapism, cardiac arrhythmias, pulmonary edema, shock, and death<sup>(3)(4)(5)(6)</sup>. Mortality is generally low and a small proportion of cases (less than 2%) need antivenom serum<sup>(3)</sup>. Pain can be controlled with nerve block anesthesia (consisting of a maximum of three sequential infiltrations of about 4ml of lidocaine without epinephrine, half in children). When antiarachnidic serum is needed, as with children and weak individuals showing systemic signs and symptoms, the number of ampoules needed is determined by the condition of the victim. A range of 2-10 ampoules may be administered intravenously, and each vial contains 5ml of serum<sup>(3)(4)(5)(6)</sup>. 3) Brown-spiders: *Loxosceles* spiders live in dark, dusty environments. They are shy and only bite when pressed or handled. The most important component of their venom is sphingomyelinase D, an enzyme that destabilizes vessel walls and red blood cell membranes and causes extensive skin necrosis and hemolysis with the risk of acute renal failure (the latter is seen in 5% of patients)<sup>(5)(6)</sup>. Local symptoms can include a burning sensation or moderate pain. In a few hours, an extremely painful ischemic area with pallor, cyanosis, and erythema develops, creating the characteristic *marble plaque*. The plaque may also have hemorrhagic blisters. Full necrosis manifests in approximately seven days, resulting in a blackened and insensitive eschar adhered to the deep skin layers<sup>(5)(6)</sup>. The deployment of the eschar occurs after approximately one month, leaving an extensive and deep ulcer with a granular base and raised edges. These ulcers may resemble those caused by mucocutaneous leishmaniasis, cutaneous tuberculosis, squamous cell carcinoma, and sporotrichosis. The ulcer may take several months to heal. Treatment depends on the stage of the envenomation and there is no established timeframe



**FIGURE 1 - Above, left: *Loxosceles* sp., the brown spider; a marble plaque; and a chronic ulcer caused by a bite from this species. Below, left: *Phoneutria nigriventer*, the banana spider; *Latrodectus curacaviensis*, the black widow; a *Migalomorpha* spider; and *Tityus serrulatus*, the yellow scorpion. Photographs: Vidal Haddad Junior and Clêndisso Rodrigues (*Latrodectus*).**

for the use of antiarachnidic serum. Moderate cases (systemic changes without hemolysis) may need 5 ampoules and severe cases (with hemolysis) may require up to 10 ampoules. When there is necrosis without hemolysis, it is possible to use sulfone (100-300mg/day orally), which acts by blocking neutrophil diapedesis and inhibiting the extension of necrosis. The administration of oral corticosteroids is controversial, but indicated in some protocols. In later stages, extensive and slow healing ulcers can be treated with skin grafts<sup>(3)(4)(5)(6)</sup>. Cutaneous loxoscelism is not uncommon. Thousands of bites are reported annually in Curitiba, State of Paraná, Brazil. The Vital Brazil Hospital (Instituto Butantan) sees an average of 50 cases per year<sup>(6)</sup>. 4) Black widow spiders: These spiders are represented worldwide by the *Latrodectus* genus, with *Latrodectus mactans* being the most important species in the Americas, for the severity of the envenomation. The brown widow (*Latrodectus geometricus*) is a common spider that causes less serious injury. These spiders have a characteristic hourglass design on the ventral abdomen. The venom of the black widow causes myalgias, paresthesias, muscle contractures, drooling,

nausea, vomiting, arterial hypotension, shock, and death in some cases. The species *Latrodectus curacaviensis* (*flamenguinha*) predominantly causes injuries in the States of Rio de Janeiro and Bahia. Treatment requires 1 or 2 antilatrodectic serum vials, depending on the severity of the symptoms. Benzodiazepines are also used to promote muscle relaxation<sup>(3) (4) (5) (6)</sup>. 5) Other spiders: Wolf spiders (*Lycosa*) are common in urban areas. Their bite is moderately painful but does not cause significant envenomation. Tarantulas (Mygalomorphae) are giant spiders of up to 20cm in length whose venom is mildly toxic to humans. When threatened, these spiders can shoot abdominal bristles that cause an erythematous papular dermatitis in people who keep the spiders as pets or work in vivariums. Treatment of the dermatitis is symptomatic, with antihistamines and topical corticosteroids<sup>(5)(6)</sup>.

**Scorpions.** Scorpions live in hot climates and cause a large number of human injuries each year. Of the approximately 20,000 envenomation cases registered by the Notification System of the Health Ministry of Brazil each year, approximately 8,000 are caused by scorpions. The venom of scorpions has adapted to help the animal kill its prey by promoting the release of neurotoxins and neurological transmitters that lead to central and peripheral nervous system effects.

In Brazil, the yellow scorpion (*Tityus serrulatus*) is considered the most dangerous species because it is associated with the most deaths reported to the Health System of the Health Ministry of Brazil (**Figure 1**). *Tityus obscurus* of the Amazon region causes prolonged neurological manifestations with tetany and twitching.

The scorpion uses a stinger on the telson, the last segment of the tail. The venom disrupts the autonomic nervous system by dissociating the parasympathetic and sympathetic nervous systems<sup>(3)(4)(5)(6)</sup>. The sting causes intense local pain (with minor inflammation), tachycardia/bradycardia, intense sweating, salivation, abdominal cramps, hypothermia, arterial hypo-/hypertension, mydriasis/miosis, pulmonary congestion, cardiac arrhythmias, priapism, and acute pulmonary edema. Death can occur in children and debilitated individuals.

Treatment in mild cases (which are the absolute majority of envenomations) is nerve block anesthesia using 2% lidocaine for pain control (3-4ml in adults and 1-2ml in children; application can be repeated up to 3 times at 30- to 60-min intervals). The use of oral painkillers may also be useful. In moderate and severe cases, which occur mainly in children, antivenom serum is indicated. Antiscorpionic or antiaracnic serum is used at a dose of 4 vials for mild cases (systemic manifestations are present but not intense) and 8 ampoules for severe cases (severe systemic manifestations including serial episodes of vomiting are observed). The serum should be given intravenously without dilution. The main causes of deaths are acute pulmonary edema and cardiovascular shock<sup>(4)(5)(6)</sup>.

## SUBPHYLUM MYRIAPODA

### Class Diplopoda (*pioelhos-de-cobra, centopéias, gongolôs, embuás, millipede*)

Millipedes have an elongated body composed of various segments with two pairs of legs. They are poisonous animals and release toxins when pressed or crushed (**Figure 2**). Millipedes

often enter homes and retreat to dark places, which is why many victims are bitten while putting on a shoe. Their body fluids contain toxins (cyanides and quinones) that initially cause skin and mucous membrane inflammation, and later lead to a blackish-brown hyperpigmentation at the contact location. The dermatitis does not have major clinical repercussions, but may concern the patient and a physician who is unaware of the disease. The hyperchromic lesions can persist for months<sup>(6) (7) (8)</sup>, but these inflammatory and chronic injuries ultimately disappear spontaneously. Applying alcohol and ether soon after contact appears to be useful because these agents can be toxin solvents. Ocular lesions should be washed extensively because this exposure can lead to blindness<sup>(6)(7)(8)</sup>.

### Class Chilopoda (*lacrarias, centipedes*)

Centipedes are carnivorous arthropods that also have a segmented body, but have only one pair of legs on each segment. (**Figure 2**). The first segment has two large forcipules that originate from the first pair of legs, which can inject venom contained in glands in the trunk of the animal and can be used in defense or to catch prey. The *Scolopendra* genus reaches up to 25cm long and causes the most serious injuries<sup>(6)</sup>.

The bite of a centipede causes intense pain, with local erythema and edema. In some cases, headache, malaise, anxiety, and dizziness are also observed. Rare reports of human deaths are quite unconvincing and secondary infection is the main complicating factor of the injury<sup>(6)</sup>.

Almost all envenomations caused by centipedes spontaneously resolve without complications. The site of the bite should be washed with soap and water and cold compresses are useful. Systemic analgesics are recommended to control the pain.

## SUBPHYLUM HEXAPODA

### Class Insecta

Insects are arthropods that have their name from Latin *insectum*, which signifies *body cut in sections*. They present body in three parts, an exoskeleton composed of chitin and jointed legs. The Insecta is composed by more than one million of species (about half of the living organisms in the Earth). Some insects can cause human envenomations.

### Order Coleoptera

**Beetles.** Envenomations caused by vesicant beetles are reported on every continent, excepting the Poles. The genera of beetles that most commonly provoke a linear or vesicular dermatitis in humans are *Paederus* (*potós*), *Lytta*, and *Epicauta* (**Figure 3**). The *Paederus* (family Staphylinidae), produces pederin and other toxins, which are powerful irritants to the skin and mucous membranes<sup>(1)(2)(3)(4)(5)(6)</sup>. While the *potós* were already known to the Chinese for 1,200 years, the associated dermatitis was first described in Brazil by Pirajá da Silva<sup>(9)</sup>. *Lytta* and *Epicauta* belong to the family Meloidae and feed on plants and produce cantharidin. In general, the beetles are attracted to artificial lights and enter homes or congregate in large quantities under lampposts and are also commonly found in corn and bean crops in warm, rainy months.



**FIGURE 2** - Above: millipede and centipede myriapods. Below: hyperchromic lesions caused by a centipede and a Belostomatidae giant water bug. Photographs: Vidal Haddad Junior.

The hemolymph of the *Paederus* beetles contains multiple toxins, with the most important being pederin, a crystalline amide with potent vesicant and caustic actions that is soluble in water and alcohol. The toxins of the *Paederus* spp. cause intense erythema, edema, and vesicles, which converge to form blisters. The burning and itching symptoms of envenomation by the *Paederus* are more intense than those caused by *Lytta* and *Epicauta* beetles<sup>(10)(11)</sup>.

Compression of the animal liberates toxins that often affect the posterior cervical region, face, or upper limbs of the victim. The lesions are elongated or linear, resulting from skin contact with the insect<sup>(5)(10)(11)</sup>. Some cases may present with systemic symptoms such as nausea, vomiting, and fever. The skin becomes erythematous and pruritic, with a burning sensation and vesicles that evolve into sterile pustules, ulcerations, and crusts. The manifestations resolve in approximately a week, leaving residual erythematous hyperchromic macules.

Treatment should be started with intensive washing of the affected area with soap and clean water. In established lesions, the use of potassium permanganate is useful, (1:40,000, or 1 tablet

in 4L of water) twice a day with corticosteroid creams. If there is secondary infection, the use of systemic antibiotics is necessary<sup>(5)</sup>.

## ORDER HEMIPTERA

### Family Pentatomidae

The insects of the family Pentatomidae (stink bugs, marias-fedidas, fedes-fedes) cause contact skin injuries that are similar to those associated with *Paederus* beetles<sup>(12)</sup> (**Figure 3**). The crushing of these hemipterans against the skin causes vesicular and erythematous plaques on exposed areas, which are accompanied by a burning sensation and pruritus. Treatment is similar to that employed in the linear dermatitis caused by vesicant beetles<sup>(12)</sup>.

### Family Belostomatidae

Insects of the family Belostomatidae cause painful stings in humans<sup>(13)</sup>. The water cockroaches, arauembóias, or giant water bugs are worldwide insects classified into two main genera (*Lethocerus* and *Belostoma*). These large insects are found in freshwater habitats and they are voracious predators, capable of hunting tadpoles and fish<sup>(5)</sup> (**Figure 2**).



**FIGURE 3 - Hymenoptera arthropods. Above, left: tocandira and fire ants. Above, right: pustules caused by stings of fire ants. Below: bees and wasps. Below, right: a massive envenomation caused by hybrid bees.** Photographs: Vidal Haddad Junior.

Giant water bugs can reach 10cm in size. They have a short stout beak that is used to pierce their prey and inject toxic saliva composed of enzymes that can liquefy the tissues of the prey<sup>(14)(15)</sup>. There are reports of lysophospholipids in the saliva of the species *Belostoma anurum* that can cause paralysis in the neuromuscular junctions of the prey<sup>(16)</sup>. These insects can produce very painful lesions in humans and may also carry infections. The treatment for the sting is symptomatic.

## ORDER HOMOPTERA (CICADAS)

### Family Fulgoridae (Jequitiranabóias)

Many superstitions surround the jequitiranabóias, or cicadas of the *Fulgora* genus. Called *flying snakes*, *jitiranas*, or *snakes-of-wings* by the rural population of South America, they are believed to be highly venomous to humans (Figure 3). Another unsubstantiated belief is that the insect kill the trees that it lands. In truth, these insects are completely harmless to humans<sup>(3)</sup>.

### Order Hymenoptera (ants, bees and wasps)

**Ants.** Ants belong to the family Formicidae and their stings are common in humans, particularly in rural areas. Select species cause serious complications owing to the toxicity of their venom or provocation of allergic reactions<sup>(17)(18)</sup> (Figure 4).

The most venomous ants are the bullet ants (tocandira, tocandeira, or twenty-four hour ant). Belonging to the genera *Paraponera* and *Dinoponera*, they can measure several centimeters long and have dark coloring. These ants are either solitary or live in small groups on fallen logs and rotting wood, and are found in South and Central America. The tocandira injects its venom from an abdominal stinger connected to a venom gland. The venom is a little studied protein mixture that is used by Brazilian Indians for the control of rheumatic pains. In addition, the ants are used as main part of a coming-of-age ritual of the Amazonian tribe Sateré-Maué in which youngsters introduce their hands into gloves filled with ants to test their self-control in the presence of intense pain<sup>(19)</sup>.

The red lava-pés ants or fire ants (*Solenopsis invicta*) originated in Brazil, but they were introduced to Louisiana and have since spread throughout the United States. These carnivorous ants eat a variety of prey, from insects to small mammals. The venom of this species is composed of alkaloids (originated from plant extracts), which is different than most other animal venoms, which are formed of proteinaceous material. Solenopsin A is the component of the venom that has a cytotoxic effect and causes degranulation of mast cells. There are also non-toxic proteins that can trigger allergic reactions.

Fire ants use their jaws to attach to the skin of their prey and they can sting up to 10 times with their abdominal stinger. Initial manifestations include pain, an itchy, burning sensation, and an urticated papule. Within 24 hours, the papule evolves to a sterile pustule. Multiple stings are common and cause pustulosis in children or alcoholized individuals and secondary infections can occur<sup>(17)(18)</sup>. Allergic reactions are common and can progress to anaphylactic shock. Vaccines protecting against allergic reactions to fire ants (*Solenopsis invicta*) are available in the United States, but have controversial results<sup>(17)(18)</sup>. Once *Pseudomyrmex* ants have established themselves in a *Triplaris* sp. tree, they will attack humans that come into contact with the tree. Their stings cause intense pain and discrete to moderate inflammation at the site of the sting<sup>(20)</sup>. The problem is common in some Brazilian regions and can be prevented by proper identification and avoidance of *Triplaris* sp. trees.

Ant stings are treated symptomatically with antihistamines, cold compresses to control pain, and topical corticosteroids. Massive stings should be treated with oral corticosteroids (prednisone, 30mg/day). An allergic reaction to ant stings should receive the same care as an allergy to bee stings<sup>(5)(18)</sup>.

**Bees and wasps.** Bees and wasps are venomous social insects that inject venom using a stinger in the abdomen (Figure 4). The venom provokes local reactions (papules with moderate pain and inflammation) and systemic phenomena (with multiple stings, causing myoglobinuria, renal failure, heart failure, and death). The allergic manifestations can progress to anaphylactic shock. The aggressive hybrids of African and European bees originated in Brazil and have caused various envenomations and deaths across the Americas. More than 100 stings increases the risk of death. The venom is rich in phospholipases and can cause multiple organ failure<sup>(3)(5)(21)</sup>.

The stingers remain adhered to the skin and if the venom gland is pressed, more content is inoculated. Careful removal



**FIGURE 4** - Above: vesicant beetle (*Paederus* sp.) and lesions caused by the beetle. Below: stink bug (Pentatomidae) and *Fulgora* cicada (*jequitirabóia*). Photographs: Vidal Haddad Junior.

of the remaining stingers modifies the prognosis of the victim of envenomation. The treatment of one to a few bee or wasp stings can consist of antihistamines and topical corticosteroids, but severe toxicity will require symptomatic treatment because there is no antivenom for bee stings. Appropriate emergency room treatment includes systemic corticosteroids, antihistamines, and millesimal adrenaline owing to the high risk of death<sup>(3) (5) (21)</sup>.

#### ORDER LEPIDOPTERA (MOTHS AND CATERPILLARS)

In hot and rainy months, moths of the genus *Hylesia* (family Saturniidae) mate and the females release clouds of the abdominal bristles. The bristles cause an intense dermatitis, or lepidopterism, manifested by erythematous and edematous papules and pruritus<sup>(3) (5) (22) (23) (24) (25)</sup>. Some authors believe that there are toxins in the bristles<sup>(5)</sup>. There is also the risk of severe ophthalmic involvement. Treatment recommendations include oral antihistamines for the itch, cold compresses, and topical corticosteroids.

Erucism (erucae = larvae) is caused by the larvae of moths or caterpillars (**Figure 5**). The condition is characterized by

intense pain associated with mild local inflammation and in some cases, a painful regional lymphadenopathy. Some cases present with severe local inflammation, which can provoke vesicles, blisters, and superficial necrosis<sup>(3) (5) (22) (23)</sup>. The manifestations persist for 24-48 hours. Erucism may be the most common envenomation around the world because of the proximity of these larvae to human beings, especially children. The venom contains histamine and similar substances<sup>(3) (5) (22) (23)</sup>.

The main families of Lepidoptera that causes erucism are Megalopygidae and Saturniidae. The family Megalopygidae comprises two important genera: *Podalia* and *Megalopyge*. Megalopygidae caterpillars are completely covered with bristles, while the family Saturniidae has bristles that resemble small pine trees. The most important genera associated with human injuries are of the family Saturniidae are *Automeris*, *Dirphia*, and *Lonomia*. The genera *Lonomia* and *Periga*, which are common in Central and South America, cause painful stings that lead to a hemorrhagic syndrome characterized by a decrease in fibrinogen and/or platelet aggregation inhibition. The presence



**FIGURE 5 - Above: Megalopygidae and Saturniidae caterpillars with respective lesions caused in humans. Below: *Lonomia* sp. and coagulation alterations in a patient who came into contact with a colony.** Photographs: Vidal Haddad Junior.

of ecchymosis and hemorrhagic suffusions in a victim after contact with a caterpillar indicates the possibility of contact with these specific species<sup>(3)(5)(22)(23)(26)</sup>. Victims of envenomation caused by *Lonomia* and *Periga* caterpillars that present with bleeding need hospitalization and treatment with the antivenom serum produced at the Butantan Institute, São Paulo, Brazil.

Pararamose is caused by caterpillars of the species *Premolis semirufa* in rubber tree workers of the Amazon region. Victims may be exposed as they collect sap from the rubber trees and come into contact with the potentially venomous bristles of the caterpillars, thereby setting up an initial inflammatory reaction. The edema persists for two to three days and a progressive fibrosis occurs that leads to ankylosis and loss of function in the joints of the hands<sup>(3)(5)(27)</sup>. The arthritis caused by the pararama provokes serious sequelae, once the arthritis progresses to full incapacitation of the hand joints.

The diagnosis of erucism is straightforward because the victim usually brings the caterpillar. The best method to control the pain is nerve block anesthesia with 2% lidocaine, but in children (the majority of victims), the recommendation is to apply topical commercial anesthetic creams with 0.25% lidocaine and 0.25% prilocaine<sup>(28)</sup>. Additional treatments include

the application of cold compresses, oral antihistamines, and topical corticosteroids, which reduce local inflammation, but not the pain.

## CONCLUSIONS

A great number of arthropods are venomous and their toxins provoke complex and sometimes fatal manifestations in humans. Knowledge of these envenomations and how to treat human victims appropriately is very important to professionals working in tropical medicine and emergency centers.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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