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Methods for Collecting and Capturing Scorpions: A Review

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ABSTRACT

As the study of scorpions behavior is vital and collecting methods used for capturing them play an important role, understanding the methods used for capturing scorpions seems to be essential. The present review study extracted articles related to the methods of collecting and capturing scorpions from relevant databases using the keywords scorpion, methods of collecting, collection, capturing and field. There are at least ten methods of collecting and capturing scorpions based on the study type and objectives, including the use of black light, rock-rolling, pitfall trap, water-pan trap, adobe and mud walls destruction, using a wet cloth or gunny sack, pouring water into nests, digging canal, using a rubber band and collecting them by scorpion-stung people. Black light and pitfall trap are the most widely-used methods for nighttime scorpion- capturing and rock-rolling is the most popular method for capturing in the daytime. In some cases, the researcher may use all the methods of scorpion capturing and collecting.

INTRODUCTION

Ever since the creation of mankind, humans have been faced with the problem of arthropods such as mosquitoes, flies, lice, fleas, scorpions, etc. Scorpions have long been known for their painful, venomous and in some cases fatal sting and also for their specific morphology [1]. Identifying different species of scorpion and their biological, nutritional and ecological characteristics has become a common practice in zoology and is used in scientific research in different fields such as genetics, physiology and ecology [2,3]. Just as other nations, Iranians have also studied these creatures, as scorpions have had a significant role in the Iranian imagination in the past [4,5]. They are one of the most important venomous creatures in the world and play a more significant role in tropical and subtropical areas. Annually, 1.2 to 1.5 million people are stung by scorpions across the world. In addition, deaths caused by scorpion sting are estimated to be about 3 to 5 thousand per year [6]. Scorpions are more commonly found in dry and tropical areas and in latitudes lower than the temperate zone. They live in all hot regions of the world, including deserts [7,8]. Prevalence of scorpion sting differs in different regions and countries, depending on the dominant lifestyle, socio-economic status, housing status, healthcare conditions and local species of the area. Scorpion sting is a major health problem in the Middle East and Africa [9], including Saudi Arabia [10,11], Israel [12], Morocco [13], Turkey [14], Jordan, Algeria, Egypt, Iraq, Sudan, South Africa, Madagascar, and also in South and Central America, including Brazil, Mexico, Argentina, Venezuela, Guyana and Trinidad [15-19]. For researchers active in the fields of health and medicine, scorpions are also significant from other perspectives, such as biological and ecological perspectives [20]. Every medical entomologist has to capture scorpion samples and work with them during field research. This practice usually involves the collection and storage of samples through specific methods that are often the only ones available for studying certain groups of arthropods. These methods differ for different groups of medically important insects and in different geographical regions. So far, more than 2000 species of scorpions have been identified and a number of them are of medical importance in different countries, including Iran [1,20]. One of the concerns in this area is how to capture scorpions in their natural habitats. Given the importance of scorpions, this study reviews and discusses different methods of capturing scorpions.

MATERIAL AND METHODS

The present review study extracted articles written from 1954 to 2016 by searching English and Persian databases PubMed, Scopus, Google Scholar, and SID, with the keywords scorpion, methods of collecting, collection, capturing and field. The articles that did not discuss the methods of capturing and collecting scorpions were excluded.

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RESULTS AND DISCUSSION

A total of 152 articles were extracted; after examining their titles and abstracts, some were excluded due to lacking a strong relationship with the present study objectives. Finally, 48 qualified sources on how to capture scorpions were selected and analyzed. The findings of this study are concerned with classifying, collecting and capturing scorpions depending on the need for alive or dead samples. In some cases, a certain method was used to destroy these species as a way to fight and control them. Scorpions can be collected passively or actively.

Active Collection

Black light (ultraviolet light): A distinct quality of scorpion cuticle is its fluorescence properties. This property was discovered more than 60 years ago. Pavan and Vachon [21,22] and Lawrence [23] simultaneously released reports on the fluorescence property of scorpions. This phenomenon becomes visible when ultraviolet (UV) light shines on scorpions at a wavelength of 400 to 700 nm. Pavan showed that fluorescence is concentrated in the epicuticle of scorpions [21-24]. According to researchers, *Pandinus imperator* scorpion is a species of scorpion that contains fluorescent materials [25]. The fluorescence property of scorpions increases with harder cuticles [26]. Stahnke [27] found that the concentration of fluorescent materials is low immediately after molting but reaches its maximum after 48 hours. He used an experiment to show that if a recently molted scorpion is frozen or lyophilized, no fluorescence is seen on it. Fluorescent materials are secreted by the hypodermis glands and brought on epidermis through the pore canals. This phenomenon makes the epicuticle impermeable [27,28]. Hjelle showed that fluorescent materials are concentrated in the hyaline layer. These materials are insoluble in water at a temperature below 100 °C as well as in some other substances such as ethyl ether, chloroform, acetone, benzene and toluene. But part of the materials is soluble in alcohol. Therefore, the alcohol used to keep scorpion samples has fluorescence properties [28]. Some researchers have reported that fluorescence properties owe entirely to the presence of resilin, a material formed of protein. Nevertheless, amino acids such as tryptophan and tyrosine are precursors to compounds such as beta-carboline and resilin [26]. Koehler was a researcher who studied the physical properties of fluorescence in scorpions more than any other researcher. His assumption was that this property contributes to the visibility of these creatures [29]. Scorpions and some other creatures such as crustaceans produce a green-blue light through their fluorescence property when exposed to UV light (320-400 nm). The molecules in the external skeleton absorb the UV light and re-emit it, thereby rendering it visible to humans. Beta-carboline and 4-methyl, 7-hydroxycoumarin are two major components of the scorpion cuticle and have fluorescence properties. However, some researchers have noted the lack of fluorescence properties in Chaerilids, a genus of scorpions [30]. Because of their fluorescence properties, the best time for scorpion capturing is at night by using UV light, so that they can be easily found in the dark. Scorpions can be observed at night with the help of a black light flashlight that is kept at the correct distance from the ground or brick walls and that keeps moving around; scorpions are absolutely radiant under UV light and can then be caught by forceps. The duration of each sampling varies depending on the study requirements, type and objectives. A variety of light-emitting diode (LED) lamps have been recently introduced for detecting and collecting scorpions [31]. At the present moment, most studies use black light to collect scorpions [32-39] **(Figure 1)**.

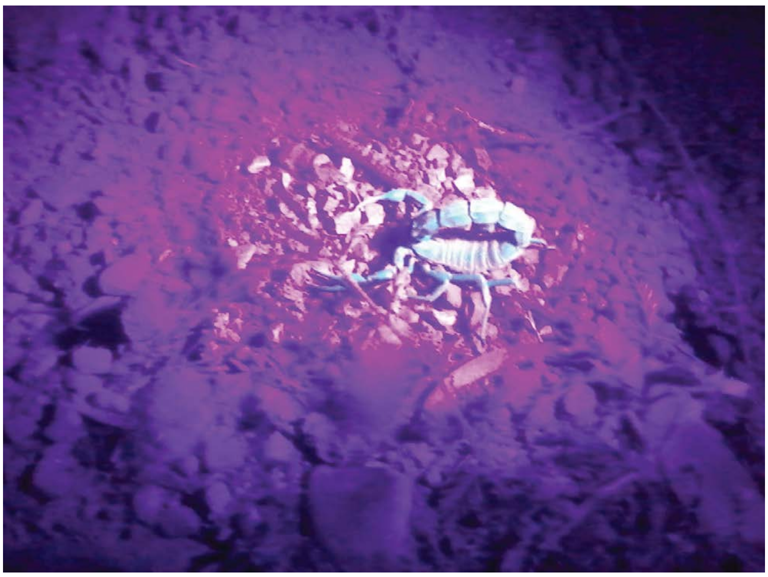

Figure 1. *Androctonus crassicauda* under UV light at night (Kashan city, Isfahan province, Iran).

Rock-rolling: Scorpions are opportunistic animals and use any hole or crack as a shelter. These creatures can easily find a suitable place for themselves in rocky areas. They usually use the cracks and holes of rocks that match the size of their bodies and to which larger animals cannot penetrate. Rock-rolling can therefore help collect scorpions. This method is one of the most common methods of capturing scorpions. Many researchers catch their samples through this method [33,34,38-42] **(Figure 2).**

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Figure 2. Collecting Hemiscorpius lepturus through rock-rolling method (Baghmalek city, Khuzestan province, Iran).

Pitfall trap: In pitfall trap method, holes are dug into the ground with specific intervals based on the study objectives and the abundance of scorpions in the area. Containers or cans are then placed inside the holes and the area around the holes is also filled to the ground **(Figure 3)**. Pitfall trap is used for capturing animals such as scorpions, lizards, centipedes, myriapoda and beetles. The map of creating these traps and their intervals and patterns vary depending on the needs and type of the study and on the type of animal targeted. Pitfall trap is mainly used for environmental studies and ecological pest control. The animal is unable to escape a pitfall trap after it is caught in it. Pitfall trap is made in various sizes and is divided into dry and wet forms. Dry pitfall trap is made by the installation of a container, can, glass or small plastic buckets in the ground. Wet pitfall trap is the same as the dry pitfall trap but contains a lethal substance for the trapped animal [43-49].

Figure 3. Collecting scorpions through pitfall trap method (Kashan city, Isfahan province, Iran).

Water-Pan trap : This method is similar to the pitfall trap, only with the difference that buckets or small bucket with a volume of about 1.5 liters and a height of 14 cm, bottom diameter of 11.5 cm and opening diameter of 13.5 cm are buried in the ground **(Figure 4)**. After the small bucket is buried in the ground, it is filled with water up to a height of 5 to 6 cm in the early evening or at dusk, and the trapped samples are collected at sunrise the next day. In this method, the samples are often smothered in water. The installation of small water bucket in the ground is more efficient in drier regions and desert areas. Scorpions are lured into these traps with the promise of water and are no longer able to escape. The map of water-pan trap varies based on the needs and type of the study. It seems that this method is efficient in hot and dry regions such as Kashan, Khuzestan and the central regions of Iran with a rainfall of up to 150 mm [35,36].

Destroying stone, adobe and mud walls : Adobe or mud walls provide a safe shelter for scorpions. Scorpions live in holes and cracks in the foundation of walls in lower ground levels, where there is sufficient moisture. Stone walls around farms made for terracing or separating farms from each other or from streams of water provide a safe haven for scorpions. In rural areas, stone walls around farms are positioned at a short distance from residential homes. The use of stone as the foundation of buildings also

Figure 4. Collecting scorpions through water-pan trap method (Kashan city, Isfahan province, Iran).

creates a suitable space and habitat for scorpions. This type of building foundation is seen more commonly in rural areas and poor communities. Destroying these walls and stone walls helps collect scorpions [35] **(Figure 5)**.

Figure 5. Collecting Hemiscorpius lepturus through destroying the old adobe and mud walls (Ramhormoz city, Khuzestan province, Iran).

Using a wet cloth or gunny sack : Because of their need for water in the hot season, scorpions are attracted to humid places in their nocturnal activities and place their body on wet surfaces. If there is enough moisture, scorpions attach their chelicera to water-bearing materials, such as wet clothes or gunny sack, for a rather prolonged time so as to absorb the required moisture through their mouth [2]. The moisture requirements of scorpions differ with their species. Scorpions' need for moisture in the hot season can be used for their collection, by dropping pieces of wet cloth or gunny sack at night and leaving the scorpions to gather in these pieces until the morning. This operation should be carried out by experienced individuals and with great caution [2,50].

Pouring water into nests : To capture digger scorpions, water is poured into their holes, when they get out, they are caught by forceps. Through this method, water is poured slowly into the scorpions' nest by a thin tube and this operation continues until the scorpion is out of its nest to avoid drowning [51-53].

Digging canal : Digging a canal to a depth of 15-20 cm with completely flat walls and filling it with water and keeping the water level high throughout the night helps attract scorpions during their active season. Scorpions approach the wet edges of the water canal and fall into it and drown. This method can be used for preventing scorpions from permeating into residential houses. Digging canal is also an appropriate measure for military forces as well as those spending short periods in training or recreational camps [54-56].

Rubber band : In this method, a rubber band is inserted into the scorpion's nest and is gently twisted. When the rubber band gets to the end of the nest and touches the scorpion, the scorpion holds it firmly with its claws. Gently pulling out the band takes out the scorpion too [38,55]. Children tend to play this trick in different areas of Iran as a simple pastime [55].

Collecting and Capturing Season

Non-digger scorpions : Scorpions tend to avoid getting wet; in rainfall, they move upward from the bottom of their habitats to escape high water levels. Many of them can thus be caught on the surface of the ground after a rainfall. This method is used to catch different species of non-digger scorpions in Khuzestan province and in the east of Iran [34].

Digger scorpions : The late of winter and the beginning of spring are the best seasons for capturing and collecting digger scorpions such as *Odontobuthus doriae* and *Scorpio maurus*; at this time of the year, the weather gets warm and scorpions begin their activity. The main sign of scorpions' activity is the mound of soil that they leave behind after cleaning their nest. This remaining mound makes it easy to identify scorpions' nests. Digger scorpions usually build their nests on steep slopes so as to avoid the penetration of rain water and its accompanying mud which can destroy their nests; additionally, this makes it easier to carry the soil they have dug [51,52,56].

Passive Collection

The collection of scorpion samples by scorpion-stung victims is a passive collection method. This type of collection is possible in hyperendemic areas of scorpion sting where numerous species of scorpions live. This method is used in epidemiological studies on scorpion envenomation. The collection of samples that have caused the sting is possible only by the healthcare authorities' instructions and order. In this method, each scorpion that has caused a sting and is brought in dead by the victim is placed in a container of 70% ethanol and its specifications are recorded separately. But if the scorpion is alive, the container lid is closed tightly by special glues so as to prevent potential damage during transportation. Usually, the victim or his relatives bring the scorpion sample to healthcare centers to be identified and a proper treatment protocol is then selected based on the type of venom the scorpion has released. In this method of collection, most scorpions are brought in killed and are morphologically damaged; therefore, their identification should be carried out by experts [57,58].

The science of zoology is rapidly growing and advancing in the identification of the different aspects of life and the characteristics of animals and their environmental and health significance. Having healthy samples is a prerequisite for the identification and evaluation of the bio-ecological characteristics of animals. To this end, measures should be taken to avoid hurting animals when searching for them and catching them. To avoid damage, it is better to examine suspicious places with forceps, wood or other proper means. As shown in studies, methods of capturing animals, such as scorpions, have changed over time and in accordance with circumstances. In some cases, researchers use a number of different methods for collecting scorpions, centipedes and myriapoda [43-59]. Ultraviolet lamps have been used for hunting scorpions for 60 years up to the present. The exact cause of the fluorescence properties of scorpions is yet to be discovered. It is not yet known whether or not this property serves for the purposes of mating, feeding or communicating with other scorpions, hence further research should be conducted on this issue. Some researchers have compared fluorescence properties among sympatric species (in biology and ecology, sympatric species are two distinct species that regularly meet in a certain geographic area), while others have studied the degree of radiance caused by this property at different times [60-62]. Other researchers have been interested in studying the changes in population frequency and other activities of these animals in different areas [63,64]. The method used for capturing scorpions is therefore particularly important. Currently, three major capturing methods are widely used, including black light and pitfall trap for capturing at night and searching under rocks for collecting in the daytime [37-39,42,59,61,65,66]. The method of capturing differs depending on the type of habitat and its topography and the study objectives. Some studies have investigated rocky areas, such as the one conducted by Farzanpay, who noted the presence of a number of species under rocks in mountains and desert areas [67]. Vazirianzadeh has caught some species such as *Hemiscorpius lepturus* (Gadim) lying under clods of mud and their natural cavities alongside irrigation canals, which, in many cases, have been due to the dredging of the canals [68]. Farzanpay also found an abundance of Gadim scorpions in rough areas and cracks in agricultural lands within rice fields formed after the last irrigation, and reported that farmers find this scorpion during winter in dried feces and manure which are to be used as fuel [67]. Zargan also caught Gadim among timbers, in the cracks of the stone walls surrounding houses and gardens, in empty cement bags or rags used to block water in irrigation canals set up for palm groves and orchards and under the leaves and cut trunks of trees [69].

CONCLUSIONS

Researchers use a variety of methods for capturing scorpions depending on the type of their study and its objectives and based on the geographic location they are searching and the existing conditions. In some cases, a researcher may use all noted methods for capturing a certain animal species. At times, new methods are used for capturing scorpions in a certain area.

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