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The assessment of biodiversity of scorpion fauna at district Karak, Khyber Pakhtunkhwa (KP), Pakistan

[a] Muhammad Goher Zaman, [a] Shakir Ullah Khan, [b] Fahim Ullah Khan *, [a] Muhammad Tanveer Khattak, [a] Abdul Musawair, [a] Muhammad Kashif, [c] Sahibzada Muhammad Jawad, [a] Sawera Nisar

[a] Department of Zoology, Government Post Graduate College Karak, KP, Pakistan,
[b] Department of Zoology, University of Science and Technology Bannu, KP, Pakistan,
[c] Department of Zoology, Islamia College University Peshawar, KP, Pakistan.

Contribution Zaman, M.G. performed sample collection, identification and analysed data, S. U. Khan, M. T. Khattak, A. Musawair, M. Kashif and S. Nisar, F. U. Khan and S. Jawad identification of specimens.

ABSTRACT

Scorpions are venomous arthropods belonging to the order Scorpions and class Arachnida. Scorpions have evolved to live in a wide range of environments, such as caves, savanna, tropical forests, rainforests, grasslands, temperate forests, and even snow-capped mountains. The purpose of this study was to create an identification key for the species and investigate the diversity of scorpion fauna in District Karak, Khyber Pakhtunkhwa (KP), Pakistan. The study was conducted between September 2023 and September 2024 and a total number of 40 specimens were collected randomly from Sabirabad, Methakhel, Hamidan, and Karak city. *Androctonus finitimus*, *Hottentotta tamulus*, and *A. balochicus* were identified as 37.5%, 35% and 27.5%, respectively. Results of the current study revealed that all of them belonged to family Buthidae. Morphometric and pectinal teeth variations were observed, suggesting the possibility of subspecies diversity or the existence of unrecorded species. The findings reveal a relatively low diversity of scorpion species in Karak compared to other regions and underscore the need for further ecological and taxonomic investigations. This research provides a foundational understanding of the scorpion biodiversity in southern KP, establishing a critical framework for future biodiversity assessments and conservation strategies.

Keywords: Arachnida, Buthidae, *Androctonus balochicus*, *Androctonus finitimus*, *Hottentotta tamulus*

INTRODUCTION: Scorpions are one of the oldest Arachnid species on Earth around 2000 known species. The Buthidae family, which includes nearly 500 species, is particularly noteworthy among the 18 recognized scorpions family. Scorpions are highly adaptable Arachnids, able to survive in extreme environment and their venom plays, a key role in their ability to survive (Newton *et al.*, 2007; Barahoei *et al.*, 2025). Scorpions have tough bodies, with a venomous apparatus located at the tip of their tails, containing two poison glands encased in thick chitin. They are nocturnal animals that can be found in deserts, mountains, caves, and beneath rocks. When disturbed they may sting accidentally, posing danger to human lives (Nejati *et al.*, 2018). Extant scorpions are easily identified by distinctive features, including a pair of chelate, pincer-like pedipalps, a post anal telson equipped with venomous stinger, and unique ventral comb like sensory organ known as pectines. Their body plan stand out among arachnids, especially in term of tagmosis. Scorpion possesses a clearly defined tripartite structure, an anterior prosoma, which bears appendages like in other chelicerates. A central mesosoma that contains the reproductive and respiratory systems and posterior tail like metasoma,which ends with the anus and proceeds the telson, consisting of a vesicle and aculus through which is delivered (Howard *et al.*, 2019).

In Pakistan, various types of scorpion habitats are present, including sandy, muddy, grassy, forested, and hilly areas; however, the variety and distribution of scorpion species in Pakistan are not well explored. Since 1900, the fauna of British India (Pakistan and India) monograph consists of limited information regarding scorpion fauna. Pocock in 1900 was the first person started the study of the scorpion in the area which is now part of Pakistan (Jawad and Zahid, 2022). Three species of scorpions, *Hottentota tamulus*, *Androctonus finitimus* and *Odontobuthus odonturus* have been found in Punjab province of Pakistan. The Buthidae family is the largest group of scorpions. They live on every continent, except Antarctica and North Pole. Buthidae scorpions thrive in tropical and subtropical areas, where warmth and humidity abound. These scorpions typically range in length from 0.8 to 4.7 inches (20-120 mm). Their sternum (chest area) has a tree like pattern which is unique characteristic of this remarkable family. Within the Buthidae family, we can find some of the longest scorpions on record, while other fall into the medium length category. This family has a wide range of sizes, showcasing nature's fascinating diversity. Their color camouflages with living environment, although some of them may appear grey and dark. There are 2 to 5 pairs of lateral eyes, and the length of telson is equal to that of abdomen and cephalothorax. The members of this family has the most extensive worldwide distribution, and also can be found in more places than other related families. The sting causes intense pain, followed by swelling and numbness. Notably, pain worse gets worse at night time discomfort. This family globally recognized for its medical significance because of nearly peptide 400 toxic peptides from Buthid scorpion venom which are highly toxic contain neurotoxic compounds that disrupt insect neural function, causing paralysis and ultimately leading to death (Brownell and Polis, 2001; Tahir *et al.*, 2015; Dehghani *et al.*, 2016; Akbar *et al.*, 2022; Jawad and Zahid, 2022; Barahoei *et al.*, 2022; Ahsan *et al.*, 2023; Xu *et al.*, 2025; Zargan *et al.*, 2025).

According to available data on scorpion Pakistan is home to five families, seventeen genera and fifty different species of scorpions. As natural predator, scorpions play a crucial role in maintaining the balance of prey population within their habitat. Changes in habitat and resource availability affect species diversity patterns along bioclimatic gradient, since community processes are largely influenced by the capability of species to adapt to environmental filtering and biogeographically processes. The loss of natural habitat and exploitation through the pet trade are key factors contributing to their extinction. Scorpion diversity in Pakistan excluding Islamabad and Karachi is remaining unexplored. Despite their importance, comprehensive identification keys for the identification of scorpion species remain undeveloped, study on their ecology and spatial heterogeneity are very few. Pet trade is the main cause of the extinction of scorpion species (Jawad and Zahid, 2022).

OBJECTIVES: The study aimed to establish the composition of scorpion fauna of District Karak Khyber Pakhtunkhwa (KP), Pakistan.

MATERIALS AND METHODS: The study was carried out from September 2023-24 in District Karak located at South of Khyber-Pakhtunkhwa (KP) Pakistan based on scorpion samples were collectted from the District Karak. The Karak district is divided into four regions: Sabirabad, Methakhel, Hamidan, and Karak City (table 1).

Location	Sample No.	coordinates
Sabirabad	10	33.0372104^{0}N, 70.9873719^{0}E
Metha khel	12	330035.40^{0}N, 70547.19^{0}E
Hamidan	11	32.9514°N 70.9681°E
Karak city	7	33.115269^{0}N 71.095535^{0}E
Total	40	

Table 1: Coordinates and habitat descriptions of scorpion.

During the field study, 40 specimens were captured using a random selection method from urban and rural areas. The scorpions were searched for under rocks, in soil gaps, in leaf litter, beneath bark, and within vegetation. Scorpions were collected with forceps, transferred to plastic jars, and preserved in 70% ethyl alcohol (Jawad and Zahid, 2022). Furthermore, nocturnal observations in above localities were conducted. The locality, temperature, humidity, and other environmental data of all captured scorpions were recorded and averaged for analysis.The air temperature ranged between 26°C and 33°C, whereas the soil values ranged

between 27 °C and 32°C. All the collected specimens were identified and brought to the faunal holdings of the Museum of the Department of Zoology, Government Postgraduate College (GPGC) Karak.

Photographs of live specimens were recorded with a digital camera (Samsung Note 10 5G), while photos for morphological characters of preserved materials were taken with the same camera. Measurements were performed in mm (Pocock, 1897). Morphological investigation and Counts of pectinal teeth were carried out under dissecting microscope (MSC-ST830). The specimens were identified by using taxonomic keys and catalogues of Kovařík and Whitman, 2005 for *H. tamulus* specimens' identification, Pocock, 1897 for *A. finitmus* specimens' identification and Pocock, 1900 for *A. balochicus* specimens' identification (Pocock, 1897).

RESULTS AND DISCUSSION: The collected samples (n=40) were from Buthidae family, 2 genera, and 3 species. In the current study, 14 were identified as *H. tamulus* (35%), 15 were *A. finitimus* (37.5%), and 11 were as *A. balochicus* (27.5%). In the study region, the scorpion fauna was *A. balochicus* (29%), *H. tamulus (*29%) and *A. finitimus (*43%). *A. balochicus* (40%), *H. tamulus (*20%), *A, finitimus* (40%) were recorded in Sabirabad. Hamidan showed the scorpions fauna of *A. balochicus* (18%), *A. finitimus (*27%), *H. tamulus* (55%). Furthermore, scorpion fauna at Metahkhel region was composed on *A. balochicus (*25%), *H. tamulus (*33%) and *A. finitimus* (42%). Among 40 scorpion samples, 28 were male and 12 were female. Gender-wise distribution of three different scorpion species in different locations of the district Karak (table 1)

Location	No of sample	*H. tamulus*		*A. finitimus*		*A. balochicus*	
		Male	Female	Male	Female	Male	Female
Sabirabad	10	2	0	3	1	4	0
Metha khel	12	1	3	2	3	3	0
Hamidan	11	4	2	1	2	2	0
Karak city	7	1	1	3	0	2	0
	40	8	6	9	6	11	0

Table 1: Gender-wise distribution of scorpion species male in district Karak.

Systematics

Phylum: Arthropoda
Subphylum: Chelicerata
Class: Arachnida
Subclass: Dromopoda
Order: Scorpiones
Family: Buthidae
Genus Hottentotta
Hottentotta tamulus

We collected the adult males with body size of 61-68mm long while adult females were 50-60mm. Coloration of carapace and mesosomal targites were reddish brown to reddish black. Pectinal teeth number in case of male was 26/27. Chelicerae were yellow and reticulated in both males and females (figure 1).

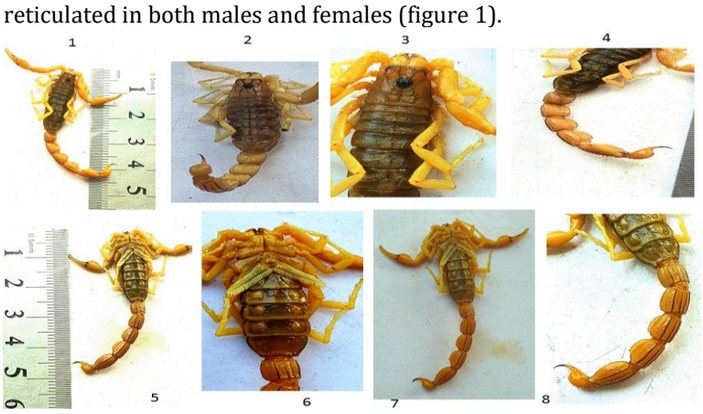

Figure 1: The male dorsal (1-4) and ventral (5-8) views of *H. tamulus*.

Chelae of pedipalps were without carinae and pedipalps were densely hirsuite while legs and metasoma were sparsely hirsute. On ventral side the seventh sternite had four well marked black carinae. Metasomal color was yellow with black ventral clear carinae. There were sparse to dense granules between metasomal carinae. First to fourth metasomal segments with ten carinae while fifth one with seven carinae. Telson was granulated and yellowish red colour. Pectinal teeth number in case of female was 23/23 (figure 2).

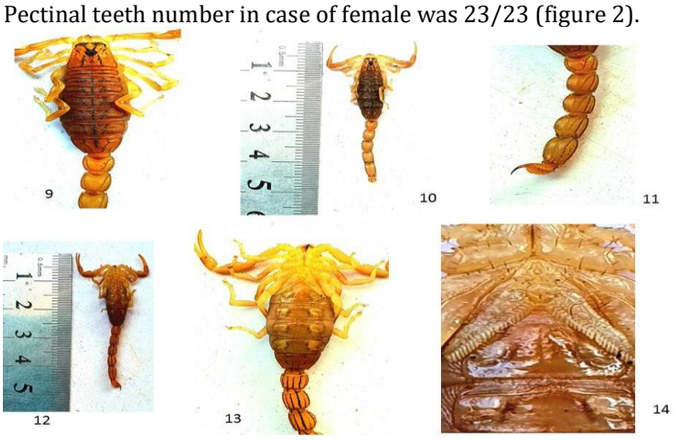

Figure 2: The female dorsal (9-11) and ventral (12-14) views of *H. tamulus*.

Systematics

Phylum: Arthropoda
Subphylum: Chelicerata
Class: Arachnida
Subclass: Dromopoda
Order: Scorpiones
Family: Buthidae
Genus Androctonus
Androctonus finitimus

We observed that the total length of males was 65-68mm while females were 60-65mm (complete set of measurements. Carapace and mesosomal colouration were reddish brown. Carapace was densely granulated with anterior and posterior median carinae. Chelicerae were without reticulation while pedipalps including trochanter and legs were yellow. In case of male pectinal teeth number was 28/29 (figure 3) while in case of female pectinal teeth number was 25/26 (figure 4).

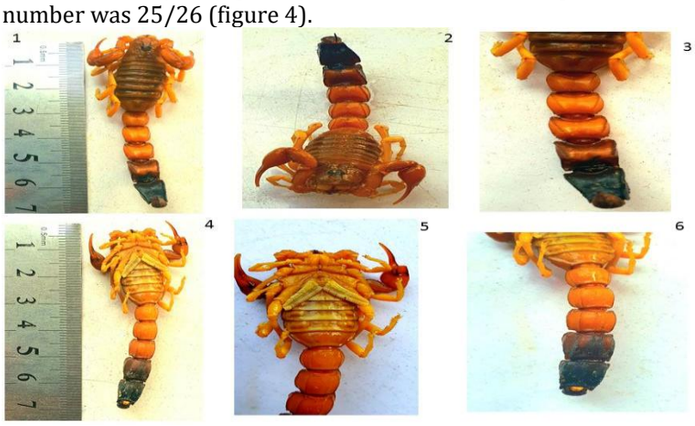

Figure 3: The male dorsal (1-3) and ventral (4-6) views of *A. finitimus*

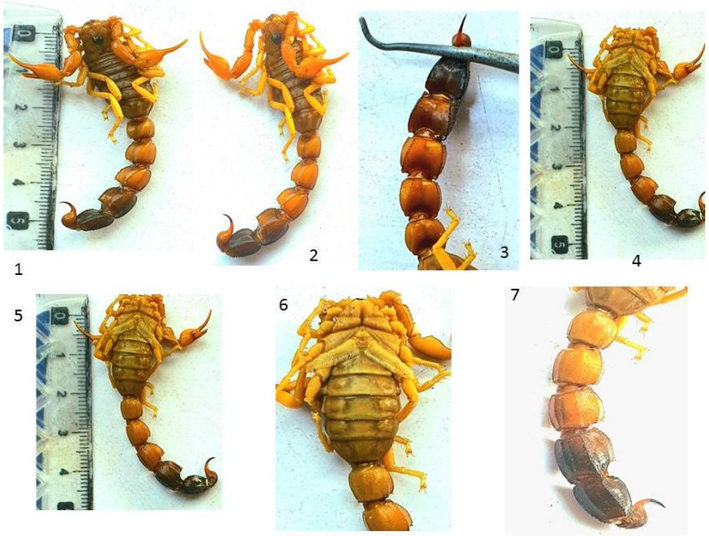

Figure 4: The female dorsal (1-4) and ventral (5-7) views of *A. finitimus*

Figure 5: The male dorsal (1-3) and ventral (4-6) views of *A. balochicus*.

Sternites were without carinae except sternite VII with four carinae. First metasomal segment of male was wider than longer, other segments were longer than wide. Third metasomal segment of male was longer than deep. First three metasomal segments were yellowish brown while the fourth metasomal segment was dorsally yellowish brown slightly but ventrally it was not entirely black (major difference between *Androctonus finitimus* and *Androctonus balochicus*). Fifth metasomal segment and vesicle were brownish black. First metasomal segment had 10 carinae, second to fourth segments were with eight carinae. Anal arch was with two or three lobes. Pedipalp chelae were without carinae. Movable fingers of pedipalps were with 13-14 rows of granules, external and internal granules.

Systematics

Phylum: Arthropoda
Subphylum: Chelicerata
Class: Arachnida
Subclass: Dromopoda
Order: Scorpiones
Family: Buthidae
Genus Androctonus
Androctonus balochicus

We found adult male scorpions with body length of 65-70mm while we did not get any female (table 2). Carapace and mesosomal targites colour was reddish brown. Chelicerae were yellow and without reticulation. Pectinal teeth number was 30/29 in male (figure 5). Sternites were without carinae except sternite VII with four carinae. Pedipals chelae were without carinae while movable fingers of pedipals with 14-15 rows of granules with external and internal granules. All metasomal segments were yellow in colour except segments IV and V included telson were entirely black or brownish black. Metasomal segment I was longer than wide while other segments were longer than wide. Metasomal segment 1 contained 10 carinae, segments II-IV with 8 carinae and segment V was with five carinae.

			Male (mm)	Female (mm)		
Carapace	Length		9.5	8		
	Anterior width		5.5	7		
	Posterior width		8.2	8.8		
	M1	Length	4.8	4.4		
		Width	4.2	5.2		
	M2	Length	5.2	5		
Metasome						
		Width	4.8	5.2		
	M3	Length	5.2	5		
		Width	4.9	5.5		
	M4	Length	5.7	5.5		
		Width	4.9	5.2		
	M5	Length	7.2	6.5		
		Width	5.0	4.9		
Mesosome	Total Length		19	20		
Telson	Length		6	6.6		
	Width		3.2	3.8		
Aculus	length		3.2	3.8		
Pedipalp			Left (mm)	Right (mm)	Left (mm)	Right (mm)
	Femur		6	5.6	7	6.8
	Patella		3	6	5	5
	Chela		10	12.1	10.5	10.5
	Movable Finger		8.0	8.0	7.5	7.5
	Fixed Finger		7.5	7.5	6.8	6.8
Pectinal	Number		26	27	23	23
Teeth	Length		7	7	7	7
Body Length	Pedipalp to Telson		76		77	
	Chelicerae to Telson		61		60	

Table 2: Comparative morphometric measurements of male and female scorpions of *H. tamulus*.

About 2000 species of scorpions are among the oldest and most adapted arachnids on the planet. They can survive in harsh conditions, and their venom is a major factor in this ability (Pondehnezhadan *et al.*, 2023). Pakistan has five families, seventeen genera and fifty species of scorpions (Jawad and Zahid, 2022). We collected total of 40 specimens of scorpions from different locations of district Karak. Khyber Pakhtunkhwa (KP), Pakistan in which after keen observation and comparison with previously identified keys, three scorpion species of Buthidae family were identified according to the keys of Pocock, 1897 *for Androctonus finitmus* (Pocock, 1897). Kovařík and Whitman, 2005 for *Hottentotta tamulus* and Pocock, 1900 for *Androctonus balochicus*. *Androctonus finitimus* has been reported in other provinces of Pakistan, it was very earlier identified by (Kovařík and Ahmed, 2013) in Sindh. Later on the same species was identified in Punjab with another closely related species *A. cholistanus*. This highlights the broader distribution of *A. finitimus* within Pakistan and emphasizes the ecological diversity these regions (Tahir *et al.*, 2015; Ahsan *et al.*, 2024). Androctonus genus is widespread and has been recorded in Balochistan province of Pakistan and Sistan province of Iran (Barahoei *et al.*, 2025). *A. baluchicus* is reported in studies conducted in Iran, *H. tamulus* is notably absent from the scorpion fauna documented there. In contrast, the Iranian scorpion fauna includes *A. crassicauda* alongside *A. baluchicus*. These findings highlight regional variations in scorpion distribution and suggest that environmental and ecological factors might influence the presence or absence of specific species in different geographical areas (Dehghani *et al.*, 2016).

			Male (mm)		Female (mm)	
Carapace	Length		9		8	
	Anterior width		6.2		6.5	
	Posterior width		10.2		11	
	M1	Length	5.5		5.5	
		Width	6.5		6	
		Length	7		6.2	
Metasome	M2	Width	6.8		6	
	M3	Length	7		6.5	
		Width	7.2		7.2	
	M4	Length	8.5		8.5	
		Width	7		6.5	
	M5	Length	8.5		7.5	
		Width	6.2		6.9	
Mesosome	Total Length		19		18	
Telson	Length		9		7	
	Width		3.5		4	
Aculus	length		3.2		3	
Pedipalp			Left (mm)	Right (mm)	Left (mm)	Right (mm)
	Femur		6.5	5.6	6	6
	Patella		8	6	7.5	6
	Chela		13.5	12.1	12.5	11.2
	Movable Finger		10	10	9	8.7
	Fixed Finger		7	7.8	6.8	7.0
Pectinal Teeth	Number		28	29	25	26
	Length		9	9	8.2	8.2
Body Length	Pedipalp to Telson		90		86	
	Chelicerae to Telson		68		65	

Table 3: Comparative morphometric measurements of male and female scorpions of *A. finitimus*.

Androctonus diversity in different provinces of Pakistan determines environmental factors, influencing scorpion diversity across these regions (Moradi *et al.*, 2020). First study that was conducted in KP region before that no such study was done in these geographical regions, Kohat, Charsada, Mardan and Peshawar districts of KP, Pakistan where five different species across three families (Scorpionidae, Buthidae and Euscorpiidae) were identified. The research was mostly focused on statistical analysis of scorpion fauna in those regions while their taxonomic marks with differences from previously published identification keys were not focused (Jawad and Zahid, 2022).

			Male(mm)	
Carapace	Length		9	
	Anterior width		6	
	Posterior width		11.5	
Metasome	M1	Length	6.2	
		Width	6.1	
	M2	Length	5.8	
		Width	6.2	
	M3	Length	6.3	
		Width	6.5	
	M4	Length	7.5	
		Width	6	
	M5	Length	8.5	
		Width	6.2	
Mesosome	Total Length		19.5	
Telson	Length		8	
	Width		2.5	
Aculus	length		4.2	
Pedipalp			Left (mm)	Right (mm)
	Total Length		23	22
	Femur		7	7
	Patella		6	6
	Chela		12	12
	Movable Finger		10.2	10.4
	Fixed Finger		8.2	8.0
Pectinal Teeth	Number		25	26
	Length		9	9
Body Length	Pedipalp to Telson		90	
	Chelicerae to Telson		70	

Table 4: Comparative morphometric measurements of male scorpion of *A. balochicus*

CONCLUSION: This study represents the first comprehensive taxonomic survey of scorpions in District Karak, documenting three species belonging to the family Buthidae: *A. finitimus* (37.5%), *A. baluchicus* (27.5%) and *H. tamulus* (35%). The ecological adaptability of *H. tamulus*, the broader distribution of *A. finitimus*, and the cross-border biodiversity connections of *A. baluchicus* underscore the ecological and biogeographically importance of these species. This research on scorpions allows for identification of venomous species and their potential effects on humans. By studying these species, we can recommend effective medical treatment in case of a sting as well as scorpion venom is being researched and used for pain management, especially in cancer treatment and autoimmune disorders. The limited scorpion diversity, shaped by environmental factors, highlights the need for further ecological and medical studies. These findings provide a foundation for advancing regional biodiversity knowledge and understanding of scorpion ecology in Pakistan. This needs further study and research in the field of scorpion fauna of district Karak.

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INFORMED CONSENT: The author(s) have reviewed the entire manuscript and approved the final version before submission.

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