ISSN: 2458-8989

Natural and Engineering Sciences

NESciences, 2024, 9 (3): 52-68 doi: 10.28978/nesciences.1606427

Comparative Study to the Sternal Region in Scorpions and Spiders

Zeina N. Al-Azawi [1*]

[1*] Department of Biology, Collage of Education for Pure Science (Ibn Al-Haitham), University of Baghdad, Baghdad, Iraq. E-mail: zeinanabil196@yahoo.com

Abstract

This study investigates the coxosternal or ventral sternal region, in scorpions and spiders. We collected 10 specimens of Scorpions from provinces Baghdad in region Abo Kreab and Salahuddin provinces in Tikrit then 7 specimens of Spiders were collected from variant regions in provinces Baghdad and various genera and families were collected and processed for examination. The aim was to compare the morphology of the coxosternal between these two arachnid groups and analyze the underlying functional and evolutionary implications of any structural variations. So the result of this study on coxosternal region of scorpions in the Family: Buthidae like *Androctonus crassicauda*, is not wide the majority of members of this family have a triangular cut and the female genital cover is divided, coxosternal region in *Orthochirus scrobiculosus* do not extend forward and do not form lobes, edges of the scales grainy and it is finely grained the majority of individuals have a triangular cut, *Mesobuthus eupeus* the ventral side is shiny and wide with strong hairs and the sternum is triangular, coxosternal region in Family: Scorpionidae like *Scorpio Maurus* in the ventral side do not have lobes extending forward, the sternum is pentagonal. But in Family: Salticidae of spiders the coxosternal region in *Hasarius adansoni*, are oval shape sternum or variable in *Thyene imperialis*, and *Evarcha seyun*, are circle shape sternum or variable, coxosternal region in *Neoscona subfusca*, family Araniedae are heart-shaped or triangular. The expected results include identifying distinct coxosternal shapes in scorpions compared to spiders. These variations might be linked to specific Roles like locomotion and internal organ protection. The determined geomorphology gets to render Understandings into the evolutionary relationships betwixt scorpions and spiders. This comparative analysis is expected to Add to a better understanding of how the coxosternal plays a role in the biology of scorpions and spiders. The known variations get bid important information along the development and practical adjustations inside these arachnids

Keywords:

Arachnida, coxosternal, evolution, morphology, locomotion, scorpion, spider, sternum.

Article history:

Received: 25/07/2024, Revised: 08/09/2024, Accepted: 10/10/2024, Available online: 31/12/2024

**Corresponding Author: Zeina N. Al-Azawi, E-mail: zeinanabil196@yahoo.com*

Introduction

The sternal region also known as the coxosternal is a vital part of an arachnid's anatomy. Away comparing the sternal regions of scorpions and spiders scientists get a clear important Understanding of how these groups of arthropods developed and modified to their environments. Despite belonging to the same class (Arachnida) scorpions (Scorpiones) and spiders (Araneae) belong to distinct orders and exhibit unique body plans. This read delves into the role variations of the sternal area in these two groups. Understanding the sternal morphology of scorpions and spiders is important for several reasons: Evolutionary Understandings: Comparing the sternal structures reveals potential evolutionary connections and adjustations within the Arachnida class. Practical significance: the cast and paper of the sternal area get work connected to particular Roles care travel sinew bond and security of in variety meat. Taxonomic identification: variations in the sternal region can help identify specific families and species within scorpions and spiders. This search aims to: compare the sternal geomorphology of scorpions and spiders poised from different locations in Iraq. Examine the structural differences between these two arachnid groups. Discourse the prospective practical and evolutionary implications of these variations (Baptista et al., 2006).

Scorpions

The sternal plate in scorpions refers to the ventral plate situated on the underside of the prosoma which is the fused head and thorax region. It is typically a clear and level provision robust base for sinew bond and back. The sternal plate plays a decisive role in the structural integrity of the prosoma contributing to the overall body framework of the scorpion. Positioned centrally along the adaxial by the sternal home serves arsenic name anatomic turning point for distinctive and classifying disparate scorpion varieties.

Sternal plate According to (Baptista et al., 2006) the sternal plate in scorpions is a vital anatomical feature situated on the ventral side of the prosoma, the fused head, and the thorax region. Its structural characteristics and functional significance are pivotal to the biomechanics, locomotion, and overall physiology of these arachnids.

Its structural characteristics and role significance are pivotal to the biomechanics locomotion and overall physiology of these arachnids. Anatomic position and composition: Baptista et al., (2006) state that the sternal plate is centrally positioned on the ventral surface of the prosoma forming a difficult Part of the scorpion's exoskeletal framework. Cool mainly of chitin bad polyps the sternal home provides inflexibility and back to the ad axial by of the prosoma (Dunlop, 2010) 's clear and level geomorphology maximizes rise field for sinew bond facilitating prompt sinew run and coordination (Bouret Campos, 1986) muscle bond and support: reported to (Di et al., 2018) the sternal plate serves as a robust foundation for the attachment of muscles involved in various physiological methods including locomotion prey capture and burrowing.

Numerous muscle bundles originate from the prosomal appendages and attach to specific regions on the sternal plate allowing for coordinated movement and control over the scorpion's body (Di et al., 2018)

The structural integrity of the sternal plate ensures that the forces Produced by muscle contractions are transmitted efficiently enabling effective propulsion and maneuverability (Dunlop & Braddy, 2001). Structural unity and function:1- Arsenic highlighted away (Herbst, 1797) the sternal home Adds importance to the structural unity and constancy of the scorpion's trunk playing arsenic tender screen for in variety meat it safeguards in variety meat such as arsenic the digestive unit face ganglia and respiratory structures from extraneous injuries or impacts (Dunlop et al., 2014). The sturdy construction of the sternal plate Improves the scorpion's ability to withstand mechanical stresses encountered during locomotion predation and defensive behaviors (Herbst, 1797)

Taxonomic and Systematic Significance

According to (Hoang et al., 2018), the geomorphology of the sternal home is a relevant taxonomical trait for variety recognition and sorting inside the rate Scorpiones.

Variation in the cast size and ornament of the sternal home provides important characteristic characters for characteristic betwixt disparate scorpion taxa (Edgar, 2004).

Systematic studies must comprise elaborate structural analyses of the sternal home to clear evolutionary relationships and phyletic Layouts among scorpion varieties (Dunlop et al., 2014). Habitats: sternum Segments: The segmentation of the sternum in scorpions is a notable anatomical Characteristic that varies across species and can provide valuable Understanding of their evolutionary history and ecological adjustations. Elaborate enlargement along the breastbone division in scorpions: variance division the breastbone in scorpions exhibits different division layouts with around variety display clear division into aggregate segments spell others get bear further united or partly split breastbone (Dunlop & Selden, 2013)

Species with segmented sternum display variations in the number and arrangement of segments ranging from two or three delineated segments to more intricate Layouts with additional divisions or subdivisions (Dunlop & Selden, 2013). This variability reflects the diverse evolutionary trajectories and ecological niches occupied by different scorpion taxa with adjustations tailored to their specific habitat preferences foraging behaviors and reproductive strategies (Dunlop & Braddy, 2001). Developmental and hereditary mechanisms mainly order the division of the breastbone regulation of the increase and morphogenesis of the adaxial exoskeleton during early and post-embryonic stages (Dunlop et al., 2014) genetic factors including the look of name restrictive genes Complicated exoskeletal lay outing and division determine the organization and coalition of breastbone segments over scorpion variety (Di et al., 2018). Environmental factors such as temperature humidity and Supply availability may also influence developmental methods underlying sternum segmentation contributing to intraspecific variation observed within populations (Dunlop et al., 2014).

Functional Implications: The degree of sternum segmentation has role implications for scorpions specifically in locomotion prey capture and reproductive behaviors (Baptista et al., 2006) species with further divided breastbone show greater tractability and mobility in the prosomal area enhancing legerity and maneuverability during search burrowing and union activities (Bouret Campos, 1986). On the other hand variety with further united or part-split breastbone gets prioritized constancy and structural unity specifically in land habitats with hard landscape or burrowing substrates (Baptista et al., 2006).

Evolutionary Significance

The evolutionary history of sternum segmentation reflects adjustations to diverse ecological pressures and selective forces over millions of years (Dunlop, 2010). Phylogenetic analyses and comparative studies of sternum morphology offer an Understanding of the evolutionary relationships and divergence Layouts among scorpion taxa elucidating the Methods shaping their anatomical diversity and ecological specialization (Dunlop et al., 2014) understanding the practical and accommodative implication of breastbone division Adds to the broader reason of arachnoid development and diversification in land ecosystems (Hoang et al., 2018). Articulation: the joint of the sternal home in scorpions is the important look of their form acting name roles in travel eating and fruitful behaviors. Detailed expansion on the articulation of the sternal plate: Anatomical Connections: The sternal plate in scorpions articulates with other ventral plates such as the coxae of the walking legs and the genital operculum (Polis, 1990; Lourenço, 2016). Joint points are special junctions where the sternal home Connections with close adaxial plates forming versatile connections that leave for drive and coordination of the prosomal area (Lourenço, 2016).

Facilitation of Movement: These articulations Ease flexibility and movement of the prosomal region enabling scorpions to perform a wide range of locomotor activities including walking running climbing and digging (Polis, 1990). The articulation points act as pivot points allowing the prosoma to flex and extend in answer to muscle contractions and external stimuli. Therefore, enhancing the scorpion's agility and maneuverability in its environment (Polis, 1990).

Functional Adaptations: The flexibility provided by the articulation of the sternal plate is essential for executing feeding behaviors, such as grasping and manipulating prey items with the chelicerae and pedipalps (Lourenço, 2016). During feeding, the sternal plate articulates with the coxae of the pedipalps and walking legs, allowing precise positioning and movement of these appendages to capture and subdue prey Additionally, articulation facilitates reproductive behaviors by enabling mating-related movements of the genital operculum and associated structures during courtship and copulation (Polis, 1990). Muscle Attachment Sites: Articulation points also serve as attachment sites for muscles involved in various physiological functions, including walking, burrowing, and prey capture Muscles originating from the prosomal appendages attach to specific regions of the sternal plate, allowing for coordinated movement and control over the scorpion's body during locomotion and other activities (Lourenço, 2016). The integration of muscle attachment sites at articulation points ensures efficient transmission of muscular forces, enabling precise control and execution of movement patterns (Polis, 1990). Evolutionary Significance: The articulation of the sternal plate reflects evolutionary adaptations to terrestrial habitats and predatory lifestyles in scorpions (Lourenço, 2016). Through phylogenetic analyses and comparative studies, researchers can infer ancestral states of articulation patterns and elucidate the evolutionary processes that have shaped the diversity of articulatory mechanisms among scorpion taxa (Polis, 1990).

Understanding the functional significance and evolutionary dynamics of sternal plate articulation provides valuable insights into the biomechanics, behavioral ecology, and evolutionary history of scorpions as iconic arachnids (Polis, 1990). Genital Operculum The genital operculum is a distinctive anatomical feature found in male scorpions, playing a crucial role in their reproductive biology. Here's a detailed expansion on the genital operculum: Anatomical Location and Structure: The genital operculum is a specialized structure located on the ventral side of the sternal plate in male scorpions (Lourenço & Gall, 2004). It is typically positioned towards the posterior end of the sternum, adjacent to the base of the walking legs or near the junction with the pectin (Lourenço & Gall, 2004). The genital operculum often exhibits morphological variations among different scorpion species, including differences in size, shape, and ornamentation (Lourenço & Gall, 2004). Reproductive Function: The primary function of the genital operculum is to facilitate the transfer of sperm during mating, thereby contributing to reproductive success in male scorpions (Lourenço & Gall, 2004). During courtship and mating rituals, male scorpions use specialized structures, such as the pedipalps and the genital operculum, to deliver sperm packets (spermatophores) to receptive females (Lourenço & Gall, 2004). The genital operculum plays a critical role in the deposition and placement of spermatophores onto the substrate or directly into the female's genital opening, ensuring successful fertilization and reproductive output (Lourenço & Gall, 2004). Mating Behavior and Adaptations: Mating behaviors in scorpions often involve intricate courtship displays and ritualized interactions between males and females (Lourenço & Gall, 2004). The presence of the genital operculum in male scorpions represents an evolutionary adaptation for efficient sperm transfer and reproductive success in competitive mating environments (Lourenço & Gall, 2004). Morphological variations in the genital operculum may reflect species-specific adaptations related to mating strategies, mate recognition, or sexual selection pressures (Lourenço & Gall, 2004): The evolution of the genital operculum in scorpions is shaped by selective pressures related to reproductive success and mating strategies (Lourenço & Gall, 2004). Comparative studies of genital morphology across scorpion taxa can provide insights into the evolutionary dynamics of reproductive structures and their functional significance in diverse ecological contexts (Lourenço & Gall, 2004).

Understanding the diversity and evolution of genital operculum morphology adds to our broader understanding of scorpion reproductive biology speciation methods and phylogenetic relationships within the order Scorpiones (Lourenço & Gall, 2004).

Protective Role: The protective Role of the sternum in scorpions is paramount for ensuring the survival and well-being of these arachnids in diverse terrestrial habitats. Here's an associate in the nursing in-depth geographic expedition of its tender role: anatomy of protection: the breastbone with different adaxial plates such as arsenic the venereal operculum and pectin’s forms iron exoskeletal Structure that encases and shields the difficult variety of meat housed inside the prosoma (Lourenço & Gall, 2004) positioned along the adaxial by of the prosoma the breastbone provides tender roadblock against extraneous threats including natural impacts rough surfaces and prospective depredation (Lourenço & Gall, 2004) safeguarding in organs: the breastbone acts of the apostle's arsenic screen for important in variety meat including the digestive unit face corduroy and respiratory structures which are difficult for the scorpion's endurance and physical operation (Lourenço & Gall, 2004).

By covering and enclosing these organs the sternum helps mitigate the risk of injuries or damage caused by environmental hazards or predatory encounters (Lourenço & Gall, 2004). defense against predation: In environments where encounters with predators are green such as arsenic deserts forests or grasslands the tender run of the breastbone becomes specifically relevant (Isbister & Bawaskar, 2014). The sturdy exoskeletal structure of the sternum serves as a deterrent against predatory attacks providing a physical barrier that improves the scorpion's ability to withstand bite strikes or crushing forces inflicted by potential predators (Isbister & Bawaskar, 2014). Adjustations to Environmental Challenges: Scorpions inhabit a wide range of habitats characterized by diverse ecological conditions including extreme temperatures arid climates and abrasive substrates (Kück & Meusemann, 2010). The protective Role of the sternum is Adjusted to mitigate the challenges posed by these environments such as minimizing water loss through the cuticle in arid habitats or reducing abrasion damage from rocky or sandy substrates (Kück & Meusemann, 2010). Consolidation with behavioral strategies: the tender run of the breastbone is complemented away behavioral strategies to adopt away scorpions to void or palliate prospective threats (Isbister & Bawaskar, 2014). Defensive behaviors such as curling the body into a defensive posture raising the metasoma (tail) with the venomous sting or burrowing into substrate further Improve the effectiveness of the sternum in safeguarding internal organs during confrontations with predators or environmental hazards (Isbister & Bawaskar, 2014).

Evolutionary Significance: The evolution of a protective sternum in scorpions reflects adaptive responses to selective pressures related to predation, environmental challenges, and survival in terrestrial ecosystems (Jago et al., 2016) Comparative studies of sternum morphology across scorpion taxa can provide insights into the evolutionary history of protective adaptations and their ecological significance in shaping the diversity and distribution of scorpions worldwide (Kück & Meusemann, 2010).

Spiders

Sternal Shield: The sternal shield in spiders is a fundamental anatomical structure situated on the ventral aspect of the cephalothorax playing decisive roles in structural support protection and muscle attachment. Here's Fancy and technological enlargement along the characteristics and Roles of the sternal shield: anatomical set and composition: the sternal screen is set along the adaxial by the cephalothorax cool mainly of chitin compound polyose (Lourenço & Gall, 2004; Poschmann et al., 2008). Its ventral position juxtaposes it with the coxae of the walking legs and other ventral appendages facilitating muscle attachment and locomotor role (Lourenço & Gall, 2004). Support and Protection: Acting as a central structural element the sternal shield provides support and stability to the spider's body shielding internal organs such as the digestive system nerve ganglia and respiratory structures from external mechanical stresses (Lourenço & Gall, 2004; Poschmann et al., 2008) it acts of the apostles arsenic tender roadblock against prospective injuries abrasions and extraneous threats enhancing the spider's general physical fitness and endurance (Lourenço & Gall, 2004) muscle bond sites: the sternal screen provides comprehensive bond sites for muscles liable for travel feed get and different physical activities (lourenço & Gall, 2004).

Muscles originating from the prosomal appendages attach to specific regions of the sternal shield facilitating precise and coordinated movements required for various behaviors (Lourenço & Gall, 2004; Poschmann et al., 2008). Integration with leg articulation: Articulation points between the sternal shield and the coxae of the walking legs allow for flexible and coordinated movement enhancing the spider's agility and maneuverability (Lourenço & Gall, 2004; Poschmann et al., 2008).

Evolutionary Significance

The presence of a well-developed sternal shield in spiders reflects evolutionary Adjustations to terrestrial lifestyles and predatory habits (Lourenço & Gall, 2004; Poschmann et al., 2008).

Comparative studies of sternal geomorphology over spider families and genera render an Understanding of the evolutionary relationships and ecologic diversification of this different arachnoid radical (Lourenço & Gall, 2004; Poschmann et al., 2008). Fusion The fusion of the sternum in spiders is a notable anatomical characteristic that Adds to the structural integrity and biomechanical Productivity of their sternal region. Here's Fancy and technological geographic expedition of the sternal coalition in spiders: anatomical considerations:

The sternum located on the ventral side of the cephalothorax undergoes fusion during development resulting in a solid and cohesive structure (Lourenço & Gall, 2004; Poschmann et al., 2008). Fusion involves the integration of individual sternum segments regulated by genetic and hormonal factors governing exoskeletal lay outing and morphogenesis. Increased constancy and rigidity: sternal coalition Improves the constancy and inflexibility of the breastbone provision iron program for sinew bond and back (Lourenço & Gall, 2004; Poschmann et al., 2008). This solid structure minimizes the risk of deformities or weaknesses ensuring optimal biomechanical Effectiveness during various activities. Optimization of sinew attachment: united breastbone offers a big rise field for sinew bond facilitating prompt infection of strong forces during drive (Lourenço & Gall, 2004). Muscles from the prosoma attach firmly to the sternum via tendons or apodemes optimizing muscle Role and coordination. Variance coalition degree: while the sternal coalition is green in spiders the point gets changed among variety (Lourenço & Gall, 2004), some variety show over coalition consequent coherent sternal screen spell others hold division or tractability perhaps reflective ecologic adjustations.

Structural implications: Sternal fusion is associated with increased biomechanical Productivity stability and muscle coordination during movement and prey capture (Lourenço & Gall, 2004; Poschmann et al., 2008). Variety with extremely united breastbone shows increased legerity and aggressive capabilities notably in hard environments. Evolutionary Significance: The evolution of sternal fusion in spiders reflects adjustations to locomotion predation and environmental factors (Lourenço & Gall, 2004). relative studies over spider taxa render Understandings into evolutionary trajectories and ecologic diversification. Attachment Site Role of the Sternum in Spiders: Anatomical and Structural Understandings. The bond place run of the breastbone in spiders plays a relevant role in their travel feed and general physical coordination. Drawing from various sources here's an in-depth exploration of this aspect: Anatomical Connectivity: Muscles responsible for important physiological Roles originate from the prosoma and attach to specific regions of the sternum via tendons or apodemes (Martill et al., 2007; Minh et al., 2013).

These attachment points provide a stable for muscle fibers facilitating robust and coordinated movements. Coordination of movement: bond to the breastbone allows for right and fast movements important for search web-constructing and apologetic behaviors (Martill et al., 2007) away catching and quiet these muscles spiders do adroit actions over aggregate appendages. Muscle Roleality: Sternum-attached muscles play decisive roles in extending and retracting legs manipulating prey and constructing silk strands (Menon, 2007). This reality enables spiders to perform intricate tasks with Productivity and precision

Biomechanical Productivity: The sternum's role as an attachment site improves biomechanical productivity by minimizing energy expenditure and maximizing muscular output (Martill et al., 2007). End propinquity to the eye of the lot reduces automatic disadvantages allowing spiders to get sound movements with nominal effort adjustations to ecologic niches:

Variability in sinew bond Layouts along the breastbone reflects Adjustations to particular ecologic niches and search strategies (Menon, 2007) different spider taxa show alone bond configurations bespoke to their habitat requirements and feed preferences evolutionary significance: the bond place run of the breastbone has evolutionary implications for the diversification and ecologic winner of spiders (Martill et al., 2007).

Comparative studies provide an understanding of the evolutionary trajectories and Adjustive radiations within the order of Araneae. Stage joint in spiders: leverage the breastbone for locomotive excellence stage joint expedited away the breastbone in spiders is important for their locomotive capabilities and accommodative conduct. Drawing from scientific literature let's Dive into the intricacies of leg articulation in spiders: Anatomical Connectivity The sternum acts as a central hub for articulation connecting with the coxae of the walking legs forming pivotal joints decisive for leg movement (Martill et al., 2007). Special structures care articulate membranes or dermal hinges enable fast and adroit motion range of motion: leg joint allows spiders comprehensive run of move important for different locomotive activities such as arsenic walk climb jump and greedy (Martill et al., 2007). This tractability enables spiders to accommodate their movements to different substrates and environmental challenges biomechanical Reality: sternum-supported stage joint Improves biomechanical Productivity away provision sound bond points for stage muscles (Martill et al., 2007). Precise control and coordination of leg movements are ensured facilitating efficient locomotion and prey capture. Agility and Adjustability: Integration of leg articulation with the sternum Improves spiders' agility and Adjustability in navigating Complicated Landscapes and capturing prey (Martill et al., 2007).

Rapid and accurate leg adjustments enable effective Answers to environmental changes predator evasion and prey capture. Specialized Behaviors: Different spider species exhibit specialized behaviors leveraging leg articulation. Cursorial hunters employ fast stage movements for chase spell web-Constructing spiders employ right stage check for silk structure (Martill et al., 2007).

Evolutionary Significance: Leg articulation, facilitated by the sternum, reflects evolutionary adaptations to terrestrial habitats and predatory lifestyles in spiders (Martill et al., 2007).

Comparative studies across spider taxa offer an Understanding of the evolutionary history and ecological diversification of this arachnid group. Variability: The variance determined in the cast and size of the sternal screen among disparate spider families and variety reflects the different evolutionary adjustations and ecological niches busy away these arachnids. Here's a detailed scientific exploration of sternal shield variability in spiders: Morphological Diversity: The sternal shield exhibits considerable morphological diversity across spider taxa encompassing variations in shape size surface texture and ornamentation (Pepato et al., 2010). Species may have a range of sternal shield shapes from small and compact to larger and more elongated structures influenced by ecological requirements and structural needs. adjustations to lifestyles: the variance in sternal geomorphology is closely connected to the particular lifestyles and ecologic niches busy away disparate spider taxa (Pepato et al., 2010).

Cursorial hunters may have streamlined sternal shields for rapid movement while ambush predators may possess broader and heavily armored shields for protection during concealed ambushes. Feed preferences: the cast and size of the sternal screen get work influenced away the pet feed of spider variety (Perry, 1995). Species hunting large prey may have reinforced shields to withstand forces during capture while those hunting small prey may prioritize agility with lighter shields. Environmental adjustations: environmental factors such as arsenic habitat case and substratum paper determine sternal geomorphology (Pointon et al., 2012) species in hard habitats get bear thicker shields for security spell those in wet environments get prioritize flexibility evolutionary significance: comparative studies of sternal geomorphology render Understandings into the evolutionary adjustations and ecologic variety of spiders (Pocock, 1888). Phylogenetic analyses clear Layouts of structural overlap discrepancy and accommodative radiation inside spider evolution (Pointon et al., 2012).

Comparative Study

Morphological differences: A comprehensive comparative study of the sternal regions in scorpions and spiders can reveal significant morphological differences providing an Understanding of the evolutionary adjustations and ecological diversity of these arachnids. Here's however such as read power analyses the structural variations: cast and size: scorpions typically have clear and level sternal home spell spiders bear a further united and good sternal shield. The sternal home in scorpions tends to work big and further long relation to their trunk-sized provision good rise field for sinew bond and back. In contrast, the sternal shield in spiders may vary in shape from rounded to elongated depending on the species' ecological niche and locomotor adjustations. Segmentation: scorpions show versatile degrees of division in the sternal home with around variety having clear segments apart away sutures spell others bear further united or partly split breastbones. Spider sternums are typically more fused forming a relatively solid structure without distinct segments or divisions. Notwithstanding around taxa get hold of rudimentary division or show insidious variations in dermal texture (Pepato et al., 2010).

Specialized Structures: Male scorpions often bear a genital operculum on the sternum which is a specialized structure involved in mating behavior and reproductive success. Spiders may possess specialized structures on the sternum related to their predatory habits or silk production. For cases around variety bear limited setae or spines along the sternal screen aiding in feed get or defense (Perry, 1995). Presence of apodemes or Tendons: Both scorpions and spiders have internal structures such as apodemes or tendons that attach muscles originating from the prosoma to specific regions of the sternal region. These bond sites run relevant Role in facilitating sinew run and biomechanical Productivity during drive and feed get. Structural adjustations: Morphological differences in the sternal region reflect structural adjustations to the ecological niches and predatory strategies of scorpions and spiders. Scorpion sternal plates are modified for iron back security of in variety meat and prompt sinew bond important for their burrowing modus vivendi and aggressive conduct.

Spider sternal shields are improved for agility flexibility and precise leg articulation facilitating diverse locomotor activities prey capture and web-constructing behaviors. Evolutionary implications: relative analyses of sternal geomorphology render important Understandings of the evolutionary relationships and accommodative radiation inside the arachnoid clade. Layouts of morphological convergence or divergence in the sternal region can elucidate the evolutionary trajectories and ecological specialization of scorpions and spiders in terrestrial ecosystems (Pepato et al., 2010). In succinct relative read of the structural differences in the sternal regions of scorpions and spiders reveals alone adjustations and evolutionary innovations that bear wrought their anatomic variety and ecologic winner arsenic iconic arachnids. Structural adjustations: Investigating how differences in sternal morphology relate to the Structural adjustations of scorpions and spiders provides a valuable understanding of their ecological roles predatory strategies and reproductive behaviors. Here's however such as associate in nursing probe power unfold: modes of locomotion: scorpions mainly employment land way of travel defined away walk and burrowing behaviors. Their broad and flat sternal plate provides a stable platform for muscle attachment facilitating efficient movement across diverse substrates.

Spiders exhibit a diverse range of locomotor strategies including walking climbing jumping and web-swinging. The further united and good sternal screen in spiders Improves biomechanical Productivity and legerity facultative right stage joint and fast movements important for navigating compound environments and capturing feed (pepato et al., 2010). Feed-get strategies: scorpions trap predators that bank along stealing and forbearance to get feed. Their sternal morphology characterized by a robust and well-developed sternum with specialized structures such as pectin and sensory hairs Improves their ability to Find and immobilize prey effectively. Spiders' employment breed of feed get strategies including web-constructing stalk and dynamic search. The shape and size of the sternal shield in spiders may be tailored to their specific hunting techniques with cursorial hunters possessing streamlined sternums for rapid pursuit while web-constructing species have broader sternums for anchoring silk threads during prey capture (Pepato et al., 2010).

Reproductive Behaviors: Male scorpions often exhibit specialized structures such as a genital operculum on the sternum which are involved in mating behaviors and sperm transfer. The geomorphology of the sternal home in virile scorpions gets work modified to suit these fruitful structures and help the eminent union. Spiders also display diverse reproductive behaviors including courtship rituals mate attraction and egg-laying. The sternal screen in Spiders gets run Role in match credit or show during suit with variations in cast and ornament Arguably influencing match quality and fruitful winner. (Perry, 1995). Ecologic niches and adjustations: differences in sternal geomorphology betwixt scorpions and spiders muse their adjustations to particular ecologic niches and environmental conditions. Scorpions inhabit a wide range of terrestrial habitats from deserts to forests where their sternal morphology provides stability and support for burrowing and prey capture. Spiders take different ecologic niches including forests grasslands and citified environments with their sternal geomorphology modified to help travel feed and web-constructing behaviors Characteristic of their several habitats. Evolutionary Trajectories: Comparative analyses of sternal morphology and structural adjustations provide an Understanding of the evolutionary trajectories of scorpions and spiders within the arachnid clade. Layouts of structural overlap or discrepancy in the sternal area muse the exclusive pressures and ecologic interactions that bear wrought their evolutionary account and diversification.

In summary differences in sternal morphology between scorpions and spiders are intricately linked to their structural adjustations including modes of locomotion prey capture strategies reproductive behaviors and ecological niches. Investigation of these relationships Improves our reason of the ecologic roles and evolutionary kinetics of these iconic arachnids in land ecosystems. Evolutionary implications: Exploring the evolutionary history of the sternal regions in scorpions and spiders provides an Understanding of how these arachnids have diverged over time and adjusted to various ecological roles. Here's an associate in the nursing geographic expedition of the evolutionary implications: past origins: scorpions and spiders lie to clear arachnoid lineages with past origins dating game hundreds of billions of age. Fossil records indicate that both groups have existed because of the Silurian and Devonian periods respectively. The sternal area potential developed new in the account of arachnids arsenic break of the division and specialty of the cephalothorax facilitating travel feed get and security of difficult variety meat (Perry, 1995).

Divergence and Radiation: Scorpions and spiders diverged from a common ancestor in the early evolutionary history of arachnids leading to the componence of distinct sternal morphologies Adjusted to their respective ecological roles. Across billions of ages, scorpions and spiders underwent evolutionary radiations diversifying into a comprehensive range of variety occupations different habitats, and ecologic niches (Pepato et al., 2010). Ecological Specialization: The evolutionary history of the sternal regions in scorpions and spiders is closely linked to their ecological specialization and adjective radiation. Scorpions modified to land environments evolving iron sternal plates fit for burrowing trap depredation and endurance in dry habitats. Spiders diversified into numerous ecological niches including web-constructing hunting and scavenging with their sternal morphology reflecting adjustations to locomotion prey capture and reproductive behaviors. Exclusive pressures: evolutionary changes in the sternal regions of scorpions and spiders were determined away exclusive pressures relevant to habitat variety feed accessibility contention and environmental changes across geologic sentence scales. Morphological adjustations in the sternal region such as variations in shape size segmentation and the presence of specialized structures conferred fitness advantages that allowed these arachnids to exploit diverse ecological supplies and ecological niches (Pointon et al., 2012).

Convergence and Divergence: Despite their shared ancestry scorpions and spiders exhibit both convergent and divergent evolution in their sternal morphology. Focused development is manifest in the practical similarities determined in the sternal regions of scorpions and spiders such as arsenic their roles in travel feed get and security. However divergent evolution has led to distinct Adjustations and morphological innovations in the sternal regions of scorpions and spiders reflecting their unique ecological roles and evolutionary trajectories.

Phylogenetic Studies: Phylogenetic analyses based on molecular Information fossil evidence and morphological characters provide valuable Understandings of the evolutionary relationships and divergence times of scorpions and spiders. Relative studies of sternal geomorphology over disparate arachnoid taxa lead to our reason for the evolutionary Layouts and methods of formation of the variety of sternal regions in these past arachnids. In summary, the evolutionary history of the sternal regions in scorpions and spiders is characterized by divergence adjustation and ecological specialization over geological time scales. Reason these evolutionary implications Improves our hold of the ecologic roles and evolutionary kinetics of these iconic arachnids in land ecosystems (Pointon et al., 2012). Ecologic significance: assessing however the Edition in sternal geomorphology influences ecologic interactions and corner distinction among scorpions and spiders provides an Understanding of their roles as arsenic predator's competitors and habitat specialists. Here's an assessment of the ecological significance: Predation.

Variations in sternal morphology can influence predatory strategies and Productivity in both scorpions and spiders. Scorpions with iron and hard divided sternal plates are well-adjusted for trap depredation arsenic they get dwell obscure in burrows or crevices relying along their right claws and cut to get feed in line spiders with further united and efficient sternal shields show increased legerity and maneuverability facultative them to actively run feed stem or trap insects exploitation their acid fangs or awkward silk duds. Competition: Differences in sternal morphology can influence competitive interactions among scorpions and spiders sharing similar habitats or ecological niches. In Supply-limited environments, variety with special sternal structures bears aggressive vantage across others. Habitat Preferences: variation in sternal morphology reflects adjustations to specific habitat types and environmental conditions. Scorpions and spiders show habitat preferences founded along factors such as arsenic wet levels temperature substratum paper and flora back. Scorpions with segmented sternal plates are often associated with arid or semi-arid environments where they can burrow into sandy or rocky substrates to escape extreme temperatures and predation pressure.

Spiders with fused sternal shields may thrive in a wide range of habitats, including forests, grasslands, and urban environments, where they can exploit diverse prey resources and microhabitats for web-building, hunting, or shelter (Perry, 1995). Niche Differentiation: variation in sternal morphology contributes to niche differentiation among scorpions and spiders, allowing them to occupy distinct ecological roles and exploit different resources within their habitats. Within a given habitat, species with specialized sternal structures may partition resources such as prey, shelter, and breeding sites, reducing direct competition and promoting coexistence. Niche differentiation facilitated by sternal morphology enhances the overall biodiversity and ecological stability of terrestrial ecosystems, as scorpions and spiders play important roles as predators, prey, and ecosystem engineers. Response to Environmental changes in environmental conditions, such as climate change, habitat loss, or invasive species introductions, can exert selective pressures on sternal morphology and influence ecological interactions among scorpions and spiders. Species with greater morphological plasticity or adaptive capacity in their sternal regions may be better equipped to cope with environmental fluctuations and maintain population viability in rapidly changing landscapes (Pocock, 1888). In summary, variation in sternal morphology influences ecological interactions and niche differentiation among scorpions and spiders by shaping their predatory strategies, competitive abilities, habitat preferences, and responses to environmental changes. Understanding these ecological dynamics is essential for conservation efforts and ecosystem management in terrestrial habitats where these arachnids play critical roles as predators and ecosystem regulators. (Perry,1995). By conducting such a comparative study, researchers can gain a deeper understanding of the anatomical, functional, and evolutionary aspects of the sternal regions in scorpions and spiders, shedding light on their remarkable diversity and adaptation within the arachnid lineage.

Materials and Methods

Specimens: 10 scorpions *from* genera *Androctonus, Orthochirus, Mesobuthes, and Scorpio* (Buthidae and Scorpionidae families), 7 spiders *from* genera *Hasarius, Thyene, Evarcha, and Neoscona* (Salticidae and Araneidae families).

Collection: Scorpions were collected from agricultural lands under stones and leaves, while spiders were collected by hand, sweep nets, and pitfall traps we collected Scorpions from provinces Baghdad in region Abo Kreab and Salahuddin provinces in Tikrit then Spiders were collected from variant region in provinces Baghdad (Al-Kadhimya, Zayouna, Al-Jadriya and Al-Za'franiya) during 20 April 2023 to 29 July 2023.

Preservation: Scorpions were killed using thermal shock followed by fixation solution. Formalin 12 parts, isopropyl or propyl alcohol (99%) 30 parts, Glacial acetic acid 2 parts, and Distilled water 56 parts put in this solution for two days, then transferred to isopropyl alcohol 70% for one hour, then transferred to 30% alcohol then transferred to 30% alcohol (Al-Azawi & Bassat, 2016), Spiders were preserved in 70% ethanol with glacial acetic acid.

Identification: Scorpions were identified according to the keys of (Kovarik, 1999; 2009). and spiders were identified using taxonomic keys to the family (Jocque & Dippenaar-Schoeman, 2006; Nentwig et al., 2021).

Examination: Specimens were examined under dissecting and compound microscopes for detailed observation of the sternal region.

Documentation: Images were captured using a camera with 10-pixel resolution.

Results and Discussion

Coxosternal region in *Androctonus crassicauda*, Familyb:Buthidae Figure (1): Coxosternal region (Co) is not wide, the majority of members of this family have a triangular sternum (TSt), which is a prominent feature in this family, while the plates of the book lungs (Bl.) are elongated, and the female genital cover (Go.) is divided.Coxosternal region in Orthochirus scrobiculosus, Family: Buthidae (Figure 2) The Coxosternal region (Co) does not extend forward and does not form lobes, edges of the scales grainy and it is finely grained the majority of individuals have a triangular sternum (TSt). Figure (3): Coxosternal region in Mesobuthus eupeus, Familyb: Buthidae The ventral side is shiny and wide with strong hairs and the triangular sternum, (TSt.) Figure (4): Coxosternal region in Scorpio maurus, Family: Scorpionidae Coxosternal region (Co.) from the ventral side do not have lobes extending forward, have pentagonal sternum (PSt).

In summary, the sternal plate in scorpions serves as a multifunctional anatomical structure essential for muscle attachment, structural support, and taxonomic identification. Its intricate morphology and functional adaptations reflect the evolutionary history and ecological adaptations of scorpions as highly specialized arachnids inhabiting diverse terrestrial habitats, sternum segmentation in scorpions is a dynamic and evolutionarily significant trait shaped by genetic predispositions and environmental influences. Research on sternum segmentation provides valuable insights into their evolutionary history, ecological adaptations, and behavioral ecology, the articulation of the sternal plate in scorpions is a complex and adaptive trait that facilitates movement, feeding, and reproductive behaviors. Its anatomical connections and functional adaptations underscore its importance in the biomechanics and ecological success of scorpions in diverse terrestrial habitats., the genital operculum in male scorpions is a specialized structure involved in mating and reproductive success. Its anatomical features, functional adaptations, and evolutionary significance highlight the complex interplay between morphology, behavior, and reproductive strategies in scorpions as iconic arachnids, the protective function of the sternum in scorpions is a critical adaptation that enhances their survival and resilience in challenging terrestrial environments. Its anatomical features, ecological adaptations, and behavioral strategies underscore its importance as a key component of the scorpion's exoskeletal armor.

Spiders

Sternum in spiders: A non-fragmented plate structure located on the ventral side of the spider's body. The front part of the shear is characterized by the presence of a groove Distinct groove in Mygalomorphae carrying the shear small circles or oval or variety shape in the Salticidae family or heart-shaped or triangular in the Araniedae family. In most spiders, the labium and sternum are hinged together by a cuticle membrane pleurae the sternum bears sigilla, small circular impressions on the sternum that vary in position, shape, and number between families.

Coxosternal region in *Hasarius adansoni*, Family: Salticidae Figure (5) shape Oval Sternum or variable (OS.) Figure (6) Coxosternal region in *Thyene imperialis*, Family: Salticidae shape Circle Sternum or variable (CS.) Figure (7) Coxosternal region in *Evarcha seyun*, Family: Salticidae shape Circle Sternum or variable (CS.) Figure (8): Coxosternal region in *Neoscona subfusca*, family Araniedae heart-shaped or triangular (TS.) The sternal shield in spiders is a complex and versatile structure that fulfills essential roles in locomotion, protection, and physiological integration. Its anatomical features and functional adaptations highlight the intricate interplay between morphology, biomechanics, and ecological interactions in these iconic arachnids, sternal fusion in spiders is a crucial adaptation enhancing stability, rigidity, and biomechanical efficiency. Its variability among species underscores its evolutionary significance and functional versatility in facilitating diverse behaviors and ecological adaptations, the attachment site function of the sternum in spiders is integral to their biomechanical efficiency, locomotor coordination, and predatory prowess. Its anatomical connectivity with prosomal muscles highlights the intricate relationship between morphology, physiology, and ecological specialization in these remarkable arachnids, leg articulation supported by the sternum in spiders is a fundamental adaptation that enhances their agility, adaptability, and locomotor capabilities. Its anatomical connectivity, biomechanical functionality, and adaptive significance underscore its pivotal role in the ecological success of spiders as efficient predators in terrestrial ecosystems, the variability in the shape and size of the sternal shield in spiders reflects complex interactions between ecological, behavioral, and evolutionary factors. Understanding these morphological adjustations provides identifications into the ecological diversity and evolutionary dynamics of spiders in terrestrial ecosystems. The research is expected to reveal distinct sternal morphologies between scorpions and spiders.

Scorpions from the Buthidae family might exhibit a triangular cut (TSt) and elongated lung bookplates (Bl.) while the Scorpionidae family might have a pentagonal sternum (PSt).

Spider sterna are expected to vary in shape depending on the family. salticidae spiders power bear ellipse or round genus sterna (OS, CS) spell Araneidae spiders power have simple or tripartite genus sterna (TS).

The discussion section will likely explore the functional significance of these variations, such as muscle attachment points for locomotion or leg movement in scorpions and body flexibility in spiders.

Evolutionary relationships between scorpion and spider sterna may also be discussed based on the observed similarities and differences.

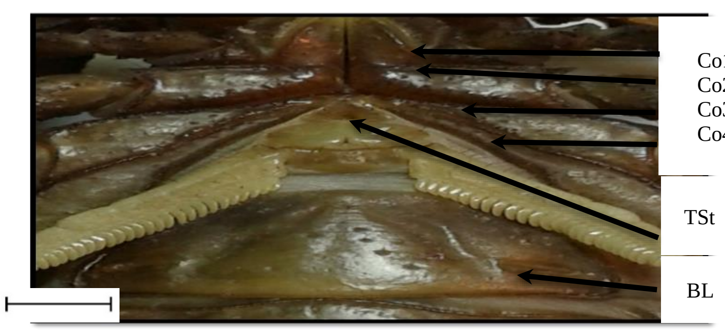

Figure 1. Coxosternal region in Androctonus crassicauda, Family b: Buthidae (400x) Coxosternal region (Co.), Triangular Sternum (TSt), Book lungs (Bl)

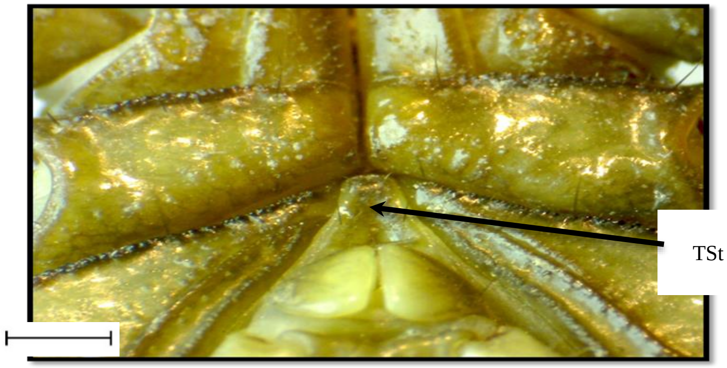

Figure 2. Coxosternal region in Orthochirus scrobiculosus, Family b: Buthidae (200x) Triangular Sternum (TSt)

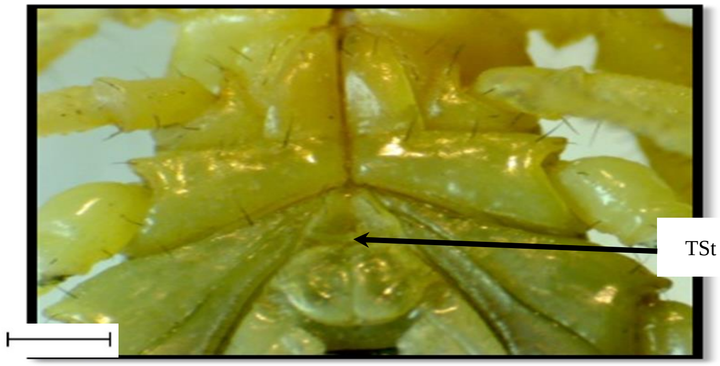

Figure 3. Coxosternal region in Mesobuthus Eupeus, Family b: Buthidae (200x) Triangular Sternum (TSt)

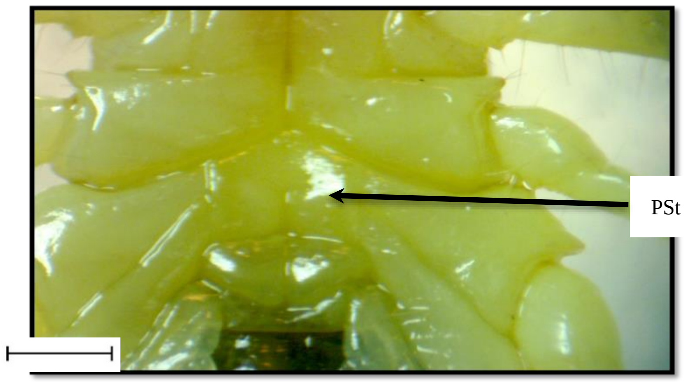

Figure 4. Coxosternal region in Scorpio maurus, Family: Scorpionidae (400x) Pentagonal Sternum (PSt)

Figure 5. Coxosternal region in Hasarius adansoni, Family: Salticidae (20x) Oval Sternum or variable (OS.)

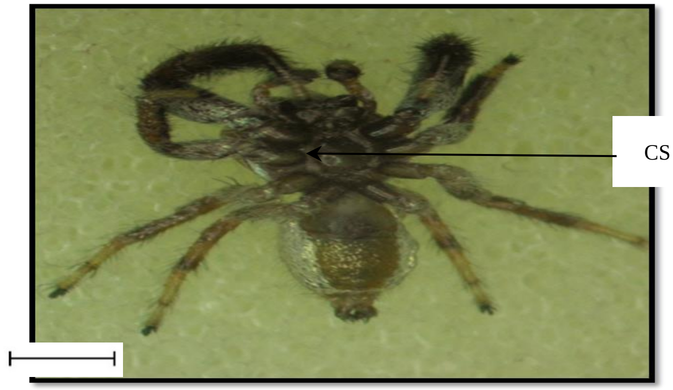

Figure 6. Coxosternal region in Thyene imperialis, Family: Salticidae (20x) Circle Sternum or variable (CS)

Figure 7. Coxosternal region in Evarcha seyun, Family: Salticidae (20x)

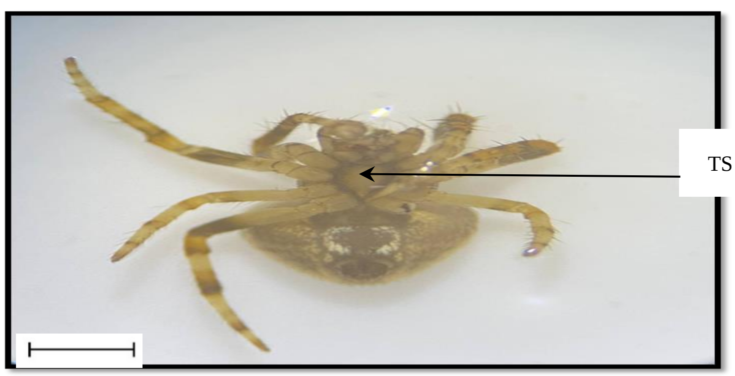

Figure 8. Coxosternal Region in Neoscona Subfusca, Family Araniedae (20x) Triangular Sternum (TS)

Conclusions

This comparative study is expected to contribute to a better understanding of the sternal region's role in scorpion and spider biology. The observed variations can provide valuable information on the evolution and functional adaptations of these arachnids. Further research might explore the connection between sternal morphology and specific behaviors within each group.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

References

Al-Azawi, Z. N., & Bassat, S. F. (2016). Taxonomic study of Androctonus crassicauda (Olivier, 1807) (Scorpiones: Buthidae) in Iraq. *Bulletin of the Iraq Natural History Museum*, *14*(1), 13-25.

Baptista, C., Santiago-Blay, J. A., Fet, V., & Soleglad, M. E. (2006). The cretaceous scorpion genus, Archaeobuthus, revisited (Scorpiones: Archaeobuthidae). *Euscorpius*, *2006*(35), 1-40.

Bouret Campos, D. R. (1986). Primeiro registro fóssil de Scorpionoidea na chapada do Araripe (Cretáceo Inferior), Brasil. *Anais da Academia Brasileira de Ciências*, *58*(1), 135-137.

Di, Z., Edgecombe, G. D., & Sharma, P. P. (2018). Homeosis in a scorpion supports a telopodal origin of pectines and components of the book lungs. *BMC evolutionary biology*, *18*, 1-7. https://doi.org/10.1186/s12862-018-1188-z

Dunlop, J. A. (2010). Geological history and phylogeny of Chelicerata. *Arthropod structure & development*, *39*(2-3), 124-142. https://doi.org/10.1016/j.asd.2010.01.003

Dunlop, J. A., & Braddy, S. J. (2001). Scorpions and their sister group relationships. In *Scorpions* (pp. 1-24). British Arachnological Society.

Dunlop, J. A., & Selden, P. A. (2013). Scorpion fragments from the Silurian of Powys, Wales. *Arachnology*, *16*(1), 27-32. https://doi.org/10.13156/arac.2013.16.1.27

Dunlop, J., Borner, J., & Burmester, T. (2014). 16 Phylogeny of the Chelicerates: Morphological and molecular evidence. In *Deep Metazoan Phylogeny The Backbone of the Tree of Life New insights from analyses of molecules, morphology, and theory of data analysis*. Berlin Boston: de Gruyter. https://doi.org/10.1515/9783110277524.399

Edgar, R. C. (2004). MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic acids research*, *32*(5), 1792-1797. https://doi.org/10.1093/nar/gkh340

Herbst, J. F. (1797). Natursystem aller bekannten in-und auslandischen. *kafer*, *7*, 1-346.

Hoang, D. T., Chernomor, O., Von Haeseler, A., Minh, B. Q., & Vinh, L. S. (2018). UFBoot2: improving the ultrafast bootstrap approximation. *Molecular biology and evolution*, *35*(2), 518-522. https://doi.org/10.1093/molbev/msx281

Isbister, G. K., & Bawaskar, H. S. (2014). Scorpion envenomation. *New England journal of medicine*, *371*(5), 457-463. https://doi.org/10.1056/NEJMra1401108

Jago, J. B., García-Bellido, D. C., & Gehling, J. G. (2016). An early C ambrian chelicerate from the E mu B ay S hale, S outh A ustralia. *Palaeontology*, *59*(4), 549-562. https://doi.org/10.1111/pala.12243

Jocqué, R., & Dippenaar-Schoeman, A. S. (2006). Spider families of the world.

Kovarik, F. (1999). Review of European scorpions, with a key to species. *Sekret*, *6*(2), 38-44.

Kovarik, F. (2009). IIIustrated catalog of scorpions Part 1, Introduction remarks, keys to families, genera and species. *Prague. Clavion. Prod*, *170*.

Kück, P., & Meusemann, K. (2010). FASconCAT: convenient handling of data matrices. *Molecular phylogenetics and evolution*, *56*(3), 1115-1118. https://doi.org/10.1016/j.ympev.2010.04.024

Lourenço, W. R. (2016). A preliminary synopsis on amber scorpions with special reference to Burmite species: an extraordinary development of our knowledge in only 20 years. *Zookeys*, (600), 75-87. https://doi.org/10.3897/zookeys.600.8913

Lourenço, W. R., & Gall, J. C. (2004). Fossil scorpions from the Buntsandstein (early Triassic) of France. *Comptes Rendus Palevol*, *3*(5), 369-378.

Martill, D. M., Bechly, G., & Loveridge, R. F. (2007). *The Crato fossil beds of Brazil: window into an ancient world*. Cambridge University Press. https://doi.org/10.1017/CBO9780511535512

Menon, F. (2007). Higher systematics of scorpions from the Crato Formation, Lower Cretaceous of Brazil. *Palaeontology*, *50*(1), 185-195. https://doi.org/10.1111/j.1475-4983.2006.00605.x

Minh, B. Q., Nguyen, M. A. T., & Von Haeseler, A. (2013). Ultrafast approximation for phylogenetic bootstrap. *Molecular biology and evolution*, *30*(5), 1188-1195. https://doi.org/10.1093/molbev/mst024

Nentwig, W., Blick, T., Bosmans, R., Gloor, D., Hänggi, A., & Kropf, C. (2021). araneae–Spiders of Europe. Version 02.2021. *Internet: https://www.araneae.nmbe*. https://doi.org/10.24436/1

Pepato, A. R., da Rocha, C. E., & Dunlop, J. A. (2010). Phylogenetic position of the acariform mites: sensitivity to homology assessment under total evidence. *BMC Evolutionary Biology*, *10*, 1-23. https://doi.org/10.1186/1471-2148-10-235

Perry, M. L. (1995). Preliminary Description of a New Fossil Scorpion from the Middle Eocene, Green River Formation, Rio Blanco County, Colorado.

Pocock, R. I. (1888). XXXII.—On the African specimens of the genus Scorpio (Linn.) contained in the collection of the British Museum. *Journal of Natural History*, *2*(9), 245-255. https://doi.org/10.1080/00222938809460919

Pointon, M. A., Chew, D. M., Ovtcharova, M., Sevastopulo, G. D., & Crowley, Q. G. (2012). New high-precision U–Pb dates from western European Carboniferous tuffs; implications for time scale calibration, the periodicity of late Carboniferous cycles and stratigraphical correlation. *Journal of the Geological Society*, *169*(6), 713-721.

Polis, G. A. (Ed.). (1990). *The biology of scorpions* (pp. xxiii+-587).

Poschmann, M., Dunlop, J. A., Kamenz, C., & Scholtz, G. (2008). The Lower Devonian scorpion Waeringoscorpio and the respiratory nature of its filamentous structures, with the description of a new species from the Westerwald area, Germany. *Paläontologische Zeitschrift*, *82*, 418-436.