

Checklist and review of the scorpion fauna of Iraq (Arachnida: Scorpiones)

Hamid Saeid Kachel, Azhar Mohammed Al-Khazali, Fenik Sherzad Hussien & Ersen Aydın Yağmur



doi: 10.30963/aramit6101

Abstract. The knowledge of the scorpion fauna of Iraq and its geographical distribution is limited. Our review reveals the presence in this country of 19 species belonging to 13 genera and five families: Buthidae, Euscorpidae, Hemiscorpiidae, Luridae and Scorpionidae. Buthidae is, with nine genera and 15 species, the richest and the most diverse family in Iraq. Synonymies of several scorpion species were reviewed. Due to erroneous identifications and locality data, we exclude 18 species of scorpion from the list of the Iraqi fauna. The geographical distribution of Iraqi scorpions is discussed. *Compsobuthus iraqensis* Al-Azawii, 2018, **syn. nov.** is synonymized with *C. matthiesseni* (Birula, 1905).

Keywords: Buthidae, distribution, diversity, Euscorpidae, Hemiscorpiidae, Luridae, Scorpionidae

Zusammenfassung. Checkliste und Übersicht der Skorpione im Irak (Arachnida: Scorpiones). Die Kenntnisse über die Skorpionfauna im Irak und deren geografische Verbreitung sind begrenzt. Die Checkliste umfasst 19 Arten aus 13 Gattungen und fünf Familien: Buthidae, Euscorpidae, Hemiscorpiidae, Luridae und Scorpionidae. Die Buthidae sind mit neun Gattungen und 15 Arten die artenreichste und diverseste Familie im Irak. Aufgrund von Fehlbestimmungen und falschen Ortsangaben werden 18 Skorpionarten für den Irak gestrichen. Die geografische Verbreitung der Skorpionarten innerhalb des Landes wird diskutiert. *Compsobuthus iraqensis* Al-Azawii, 2018, **syn. nov.** wird mit *C. matthiesseni* (Birula, 1905) synonymisiert.

المخلص: قائمة تدقيق ومراجعة لحيون العقرب (Arachnida: Scorpiones) في العراق. إن المعرفة بالعقارب العراقية وتوزيعها جغرافياً لا تزال محدودة، وقد أظهرت مراجعتنا وجود 19 نوعاً من العقارب في هذا البلد، تعود إلى 13 جنس وخمسة عوائل وهي: Buthidae، Euscorpidae، Hemiscorpiidae، Luridae والعائلة Scorpionidae. العائلة بوثيدي Buthidae هي الأكثر تنوعاً من حيث عدد الأنواع، إذ تضم 15 نوعاً تعود إلى تسعة أجناس. تم مراجعة الأسماء المترادفة Synonymies للعديد من الأنواع العراقية، فضلاً عن توزيعها الجغرافي. ونظراً للتشخيص والبيانات المحلية الخاطئة، فقد تم استبعاد 18 نوعاً من قائمة العقارب العراقية، فالنوع *Compsobuthus iraqensis* Al-Azawii, 2018, **syn. nov.** هو مرادف للنوع *C. matthiesseni* (Birula, 1905).

The scorpion fauna of Iraq is one of the least known in the Middle East. The fauna and geographical distribution of scorpions in Iraq have not been comprehensively investigated. Based on available data from the literature, it appears that several independent researchers collected specimens from various provinces of Iraq. The records of some of the identified scorpion species and their distribution are dubious and unclear, which requires further verifications. In addition, their taxonomy may need to be adjusted based on current systematic revisions. For instance, taxonomy of members of the genera *Androctonus*, *Compsobuthus*, *Mesobuthus* and *Orthochirus* still presents the main challenge despite the efforts of many researchers. The aim of this work is to review the literature on the research history of the Iraqi scorpions and provide an updated checklist for the scorpion fauna of Iraq and their geographical distribution.

Materials and methods

For this study, we reviewed publications by Simon (1880), Kraepelin (1899), Penther (1912), Birula (1910, 1918), Corkhill (1930), Kennedy (1937), Whittick (1955), Pringle (1960), L. Khalaf (1962), K. Khalaf (1963), Vachon (1966), Kovařík (1992, 2004), Lourenço & Pézier (2002), Lourenço

& Qi (2007), Sissom & Fet (1998), Fet et al. (2009), Yağmur et al. (2013), Al-Azawi (2017), Al-Khazali & Yağmur (2019), Kovařík et al. (2019b), Tahir et al. (2014) and Kachel (2020). The records given in these papers were reviewed and compared with current scorpion systematics. In addition, the administrative provinces to which the records found in those publications belong were determined.

Abbreviations of specimen repositories

AZMM: Alaşehir Zoological Museum, Celal Bayar University, Manisa, Turkey. BMNH: Natural History Museum, London, UK. FKCP: František Kovařík Collection, Praha, Czech Republic. MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland. MNHN: Muséum National d'Histoire Naturelle, Paris, France. ZISP: Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia. ZMB: Museum für Naturkunde Berlin, Germany. ZMH: Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Germany.

Geography of Iraq

The geographical distribution of scorpions in Iraq has been neglected as previous studies focused only on the systematics. Iraq, covering about 437000 km², can be divided into 18 provinces (Fig. 1). For the purpose of understanding the preferred environmental conditions and geographical distribution of each scorpion species, the 18 Iraqi provinces are grouped into four geographical regions based on their temperature, climate diversity and geographical topology (Mohammed et al. 2017): **MR** (Mountainous Region; Duhok, Erbil and Sulaymaniyah), **UR** (Undulated Region: Mosul or Ninevah, Kirkuk and Diyala), **DR** (Desert Region: Al Anbar, Baghdad, Salah ad Din, Karbala, Najaf and Al-Muthana) and **AR** (Alluvial

Hamid Saeid KACHEL, Department of General Science, College of Basic Education, University of Zakho, Zakho, Iraq; E-mail: hamid.kachel@uoz.edu.krd
Azhar Mohammed AL-KHAZALI, Department of Science / Branch Biology, College of Basic Education, University of Sumer, Dhi Qar, Iraq; E-mail: azhararach@gmail.com
Fenik Sherzad HUSSEIN, College of Science, Salahaddin University, Erbil, Iraq; E-mail: fenik.hussen@su.edu.krd
Ersen Aydın YAĞMUR, Alaşehir Vocational School, Celal Bayar University, Manisa, Turkey; E-mail: ersen.yagmur@gmail.com

Academic editor: Petr Dolejš

submitted: 28.8.2020, accepted: 25.1.2021, online: 5.3.2021

Region: Wasit, Al-Qādisiyyah, Maysan, Dhi Qar, Babil and Basra).

The Desert region (DR) with environmentally extremely harsh conditions in the west and southwest covers the largest area of Iraq. The Mountainous and highlands region (MR) with moderate temperature in the north-east and in the north is characterized by the presence of many trees, especially oaks, but also by numerous cliffs and rocks. The transitional region located between desert and mountains is undulated and hilly (UR) extending from the northern to the eastern parts of Iraq. The Alluvial region (AR) in the central and southern part of the country is characterised by scattered lakes and marshes (Malinowski 2002, Bachmann et al. 2011).

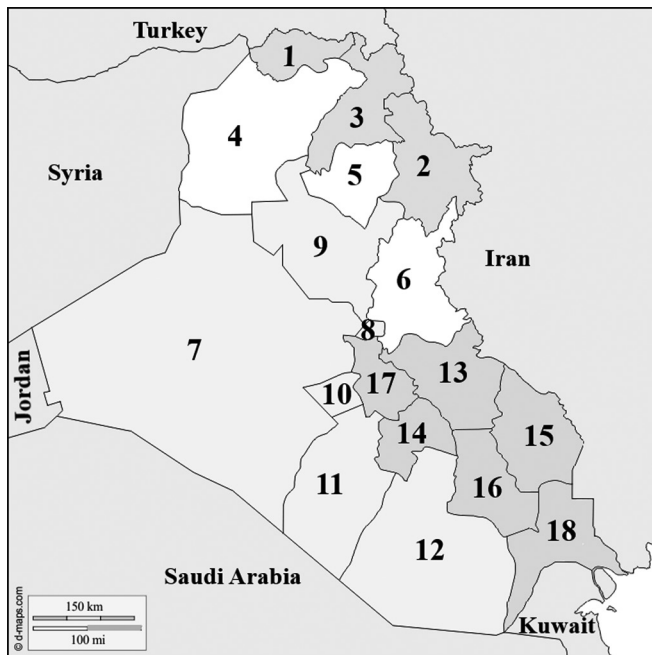


Fig. 1: Iraq map showing the approximate grouping of 18 provinces into the four major geographical regions: MR (1 – Duhok, 2 – Sulaymaniyah, 3 – Erbil), UR (4 – Mosul, 5 – Kirkuk, 6 – Diyala), DR (7 – Al Anbar, 8 – Baghdad, 9 – Salah ad Din, 10 – Karbala, 11 – Najaf, 12 – Al-Muthana), AR (13 – Wasit, 14 – Al-Qādisiyyah, 15 – Maysan, 16 – Dhi Qar, 17 – Babil, 18 – Basra), modified after Mohammed et al. (2017)

History of research on Iraqi scorpion fauna

Pioneering research (1861–1955)

Peters (1861) was the first to describe a scorpion species, *Hemiscorpius lepturus*, from what is now the territory of Iraq (Mendeli near Baghdad). Simon (1880) described *Buthus saulcyi* from Mosul Province. Kraepelin (1899), summarizing records of the known Iraqi scorpions, additionally listed *Buthus crassicauda* (Mesopotamia), *B. saulcyi* (Mosul) and *Hemiscorpius lepturus* (Baghdad). Later, Birula (1910) described the subspecies *Scorpio maurus kruglovi* from Mosul.

The earliest detailed report on the scorpions of Iraq was published by Penther (1912). When Penther carried on his fieldwork and published his paper, Iraq still did not exist as a country. Therefore, some records refer to localities within the present borders of Turkey and Syria. Penther listed six species from modern Iraq from the provinces Salah ad Din, Mosul, Baghdad and Babil.

Four studies published between 1918 and 1955 reported information on the scorpions of Iraq. Birula (1918) gave

an *Orthochirus mesopotamicus* record from Baksai (now Wasit Province, Iraq). Corkhill (1930) reported *Buthus australis* and *Hemiscorpius lepturus* from Baghdad. After that, Kennedy (1937) reported another two species from Baghdad identified as *Buthus crassicauda* and *B. eupeus*. The work by Whittick (1955) was a critical and detailed study focused on the diversity of Iraqi scorpions. He listed eight species from the provinces Baghdad, Duhok, Ninevah, Diyala, Dhi Qar, Erbil and Al Anbar.

Modern research (1960–1998)

Pringle (1960) published a comprehensive study on the scorpion fauna of Iraq based on the previous locality records of Whittick (1955), with some new observations. In his work, he reported nine different species from the provinces Baghdad, Duhok, Karbala, Diyala, Mosul, Babil, Wasit, Basra, Kirkuk, Dhi Qar and Sulaymaniyah.

A study by Leila Khalaf (1962), under the supervision of Professor Kamal Khalaf, is considered the first scientific work by Iraq's researchers conducted on scorpion samples present in Iraq in natural history institutes. Khalaf listed eight species from Baghdad, Salah ad Din, Maysan, Duhok, Erbil and Diyala provinces.

The following study by K. Khalaf (1963) did not report any new localities but listed only the 14 previously mentioned species. Vachon (1966) compiled the comprehensive list of scorpion species of the Middle East countries, including 15 species from Iraq.

Levy et al. (1973) mentioned a female of *Buthacus yotvatensis* in the BMNH collection from Hinadi (Baghdad Province), but the record is questionable since the authors did not investigate this material. Kovařík (1992) and Sissom & Fet (1998) reported three further species from Iraq.

Research after the Catalog of the Scorpions of the World (2000–2020)

After publication of the world scorpion catalogue (Fet et al. 2000), several studies contributed to the scorpion fauna of Iraq. Fet & Kovařík (2003) recorded *Euscorpius (Polytrichobothrius) italicus* from an oasis in Najaf Province (clearly introduced by humans). Kovařík (2003) described *Compsobuthus jakesi* from Najaf Province. Kovařík (2004) corrected the *Orthochirus innesi* record and described this population as a new species from Najaf Province – *O. iraqus* and synonymized *Buthus pietschmanni* with *Buthacus macrocentrus* (Kovařík 2005). *Odontobuthus bidentatus* was described from Khanaqin (Diyala Province) (Lourenço & Pézier 2002) and *Hottentotta mesopotamicus* from Zakho (Dohuk Province) (Lourenço & Qi 2007).

Fet et al. (2009) described *Calchas birulai* from Turkey and reported this species also from Iraq at Geli Ali Beg waterfall (Erbil Province). Yağmur et al. (2013) described *Calchas an-lasi* from Çukurca (Hakkari, Turkey) and suggested that the Erbil population of *C. birulai* belongs to this species. Tahir et al. (2014) recorded *Razianus zarudnyi* from Bazair (Baghdad Province).

Al-Azawi (2017) collected samples from nine provinces in the middle and south of Iraq. The scorpion species recorded were: *Androctonus crassicauda* from Abo Ghraib (Baghdad), Al Dora (Baghdad), Al-Kadhymia (Baghdad), Al-Sink (Baghdad Province), Al-Topchi (Baghdad), Batawin (Baghdad),

Al-Tagi (Baghdad) and Karbala Province; *Mesobuthus eupeus* from Al-Khalis, Baqubah (Diyala Province), Baladiyat, Abo Ghraib and Zafaraninyah (Baghdad Province); *Orthochirus scrobiculosus* from Abo Ghraib (Baghdad Province); *Hottentotta zagrosensis* from Al-Topchi, Al-Sink (Baghdad Province) and Al-Kales, Baquba (Diyala Province); *H. judaicus* from Al-Ahoiesh (Diyala Province); *Bothriurus nendai* from Abo Ghraib, Al-Nairiyaha, Baghdad Province (Baghdad Province); *Scorpio maurus* from Mishkab region (Najaf Province). Al-Azawii (2018) described *Compsobuthus iraqensis* from Tikrit (Salahuddin Province).

Al-Khazali & Yağmur (2019) reported six scorpion species from Dhi Qar Province: *Androctonus bicolor*, *Buthacus macrocentrus*, *Compsobuthus matthiesseni*, *Mesobuthus phillipsii*, *Orthochirus iraqus* and *Androctonus crassicauda*.

Kovařík et al. (2019b) reviewed *Orthochirus scrobiculosus mesopotamicus*, confirmed its validity and elevated it to species level as *O. mesopotamicus*. In addition, they described *Orthochirus fomichevi* from Sulaymaniyah and Dohuk Provinces.

Most recently, Kachel (2020) recorded *Androctonus crassicauda*, *Hottentotta saulcyi* and *Scorpio maurus* in Zakho (Duhok Province).

Comments on taxonomy

In this section, we review and confirm the names, taxonomic status, and verify the presence of all scorpion species in Iraq based on the recently updated scorpion classification.

Family Buthidae

Androctonus crassicauda (Olivier, 1807)

Androctonus crassicauda has been reported from Iraq in several studies under different names as *Buthus crassicauda* by Kraepelin (1899) and Kennedy (1937); *Prionurus crassicauda* by Penther (1912); and *Buthus (Prionurus) crassicauda* by Whittick (1955). The majority of studies have reported it under the currently accepted name, *Androctonus crassicauda*: Pringle (1960), Khalaf (1962), Khalaf (1963), Vachon (1966), Al-Azawi (2017), Al-Khazali & Yağmur (2019) and Kachel (2020).

Buthacus macrocentrus (Ehrenberg, 1828)

Buthus pietschmanni is an enigmatic scorpion species described by Penther (1912) that was later synonymized with *Buthacus macrocentrus* (Ehrenberg, 1828) by Kovařík (2005). On the other hand, Whittick (1955), Pringle (1960), Khalaf (1962) and Khalaf (1963) reported only the existence of *Buthacus leptochelys* and did not include anything about *Buthus pietschmanni*. Vachon (1966) mentioned both *Buthus pietschmanni* and *Buthacus leptochelys*. In our opinion, all *Buthacus leptochelys* records from Iraq belong to *B. macrocentrus* and, as we already mentioned, *Buthus pietschmanni* is a synonym of *Buthacus macrocentrus* (Kovařík 2005). Levy et al. (1973) listed a doubtful *Buthacus yotvatensis* record from Hinadi (Baghdad Province); presumably this record also belongs to *B. macrocentrus*. Therefore, we exclude both *Buthacus leptochelys* and *B. yotvatensis* from scorpion species list of Iraq and accept all their localities for *B. macrocentrus*.

Buthus sp.

Kovařík (1992) reported *Buthus occitanus* (Amoreux, 1789) in Iraq. However, in the last two decades, several studies demon-

strated that all populations of *Buthus* in the Middle East and Northern Africa do not belong to *Buthus occitanus* (which is restricted only to NE Spain and SW France; Sousa et al. 2017). Therefore, *B. occitanus* is excluded from the scorpion list of Iraq.

There is also an undescribed *Buthus* in Iraq, so far documented by only a single male (Sousa et al. 2017, F. Kovařík personal communication). We thus refer to this species as *Buthus* sp. pending its proper description.

Compsobuthus matthiesseni (Birula, 1905)

Whittick (1955) recorded *Buthus acutecarinatus* var. *judaicus* from Iraq. Khalaf (1962) and Khalaf (1963) reported it as *Compsobuthus acutecarinatus* while Pringle (1960) gave a record of *C. matthiesseni*. Vachon (1966) listed all three names: *Compsobuthus acutecarinatus*, *C. judaicus* and *C. matthiesseni*. *Compsobuthus matthiesseni* was described as a subspecies of *C. acutecarinatus* (Simon, 1882), and Vachon & Kinzelbach (1987) elevated it to species level. Sissom & Fet (1998) redescribed *C. matthiesseni* and confirmed its species level. Therefore, we accept all previous records of *Compsobuthus acutecarinatus* as *C. matthiesseni*. Furthermore, Fet & Lowe (2000) did not list *C. acutecarinatus* in Iraq. Lourenço et al. (2010) redescribed *C. acutecarinatus* and restricted its distribution to Yemen and Oman. Therefore, we exclude *Compsobuthus acutecarinatus* and *C. judaicus* from the scorpion list of Iraq.

Al-Azawii (2018) described *Compsobuthus iraqensis* from Iraq, but did not compare it with the two *Compsobuthus* species already known from Iraq (*C. jakesi* and *C. matthiesseni*), while comparing it with *Compsobuthus persicus* occurring only in Iran. In addition, the author did not mention the existence of *C. matthiesseni* in Iraq; the species is widely distributed there (Sissom & Fet 1998). The description of *C. iraqensis* having long and slender pedipalps and chelae, the fifth segment of the metasoma very long and narrow, and colouration of all body generally yellow to pale yellow, matches that of *C. matthiesseni*. According to Sissom & Fet (1998), in *C. matthiesseni*, the posterior median carinae terminate distally in a small spinoid process that extends slightly beyond the posterior margin of the carapace, and the central median and posterior median carinae are slightly separated by a small space, and linearly arranged. These characters match the published image of the carapace of *C. iraqensis* (Al-Azawii 2018). Based on this evidence we synonymize *Compsobuthus iraqensis* Al-Azawii, 2018 = *C. matthiesseni* (Birula, 1905), **syn. nov.**

Hottentotta mesopotamicus Lourenço & Qi, 2007 and *Hottentotta saulcyi* (Simon, 1880)

Whittick (1955) reported *Buthotus scaber* (now *Hottentotta scaber*), but Pringle (1960) did not confirm this record. Instead, he reported a yellow *Buthotus* sp. that was less hirsute than *Hottentotta saulcyi*. Subsequently, Lourenço & Qi (2007) described *Hottentotta mesopotamicus* from Zakho in northern Iraq. The characteristics of *H. mesopotamicus* were, to a certain extent, identical to the *Buthotus* sp. reported by Pringle (1960). Because *H. mesopotamicus* is uniformly yellow in coloration and less hirsute than *Hottentotta saulcyi*, we accept that Pringle (1960) recorded *Hottentotta mesopotamicus* from Khanaqin (Diyala Province). Furthermore, *H. scaber* is only known from Yemen and is therefore excluded from the list of scorpions in Iraq.

***Hottentotta schach* (Birula, 1905), *H. zagrosensis* Kovařík, 1997 and *H. judaicus* (Simon, 1872)**

Vachon (1966) listed *Buthotus schach* (now *Hottentotta schach*) for Iraq referring to Birula (1905). Recently, however, *H. schach* has been revised by Kovařík et al. (2019a) who demonstrated that the original records of Birula (1905) are only from Iran. Therefore, *H. schach* is excluded from the scorpion fauna of Iraq.

Al-Azawi (2017) reported *Hottentotta zagrosensis* and *H. judaicus* from Iraq, but it is clear from the figures given in this paper that both species belong to the genus *Androctonus*. Therefore, these two species are excluded from the list of scorpions in Iraq.

***Bothriurus nendai* Ojanguren Affilastro & Garcia-Mauro, 2010**

Al-Azawi (2017) also recorded *Bothriurus nendai* Ojanguren Affilastro & Garcia-Mauro, 2010 from the family Bothriuridae, which is present only in South America, southern Africa and Australia (Kovařík & Ojanguren Affilastro 2013). Al-Azawi's (2017) record of *Bothriurus nendai* is surely erroneous, because this species occurs only in Argentina and no species from the family Bothriuridae occur in the Palearctic region. Moreover, it is clear from the figure of *B. nendai*, that the depicted animal in fact belongs to a species of the genus *Androctonus* from family Buthidae. Thin chela on the figure strongly resemble *Androctonus bicolor*.

***Leiurus* sp.**

Sissom (1994) reported *Leiurus quinquestriatus* (Ehrenberg, 1828) from Iraq without mentioning the exact locality. Vachon & Kinzelbach (1987) did not clarify this record. Recently, Lowe et al. (2014) revised *Leiurus* populations from the Middle East and reported that the genus *Leiurus* does not occur in Iraq. However, there was a sting by *Leiurus* reported from Balad town (Saladin) by Shalita & Wells (2007). They stated the species was *Leiurus quinquestriatus* and the figure in their paper is clearly a *Leiurus*. However, *Leiurus quinquestriatus* is restricted to North Africa (Lowe et al. 2014). Therefore, this *Leiurus* population cannot be *Leiurus quinquestriatus*. Very recently, Lourenço (2020) described *Leiurus kuwaiti* from Al-Abraq, Kuwait, very close to the border of Iraq. Previous records may belong to this new species. Therefore, *Leiurus quinquestriatus* is excluded from the list of scorpion fauna in Iraq but we do not know whether the reported species could be assigned to *Leiurus kuwaiti*. Therefore, we list it here as *Leiurus* sp.

***Mesobuthus phillipsii* (Pocock, 1889)**

Penther (1912) also described *Buthus eupeus mesopotamicus*, which was synonymized with *Mesobuthus eupeus phillipsii* (Pocock, 1889) by Kovařík et al. (2011). Soon after, *M. e. phillipsii* was elevated to species level as *M. phillipsii* by Mirshamsi et al. (2011). *Mesobuthus eupeus* was reported under different generic names in previous studies. Whittick (1955) reported it under *Buthus* while Pringle (1960), Khalaf (1963), Vachon (1966) and Al-Azawi (2017) reported it under *Mesobuthus* from various areas. There is a high probability that all previous records could belong to *M. phillipsii* because it has been listed for a long time as a subspecies of *Mesobuthus eupeus*. We treat all *M. eupeus* records as referring to *M. phillipsii* and ex-

clude *M. eupeus* from the list of Iraqi scorpions. From the zoogeographical point of view, *Mesobuthus eupeus* occurs on the north to the Zagros-Taurus mountain range, thus does not reach Iraq in its distribution (Mirshamsi 2013). Al-Khazali & Yağmur (2019) recently reported only *M. phillipsii*.

***Olivierus caucasicus* (Nordmann, 1840)**

The genus *Olivierus* was described by Farzanpay (1987) (with the type species *Buthus caucasicus*) and was synonymized with *Mesobuthus* by Gantenbein et al. (2003); Kovařík (2019), however, reestablished the genus *Olivierus*. Although Zhang et al. (2020) did not accept it, we follow and accept the results of Kovařík (2019). The genus *Olivierus* is not found south of the Zagros-Taurus mountain range. Therefore, Penther's *Olivierus caucasicus* record is very doubtful, and *O. caucasicus* has not been confirmed in Iraq again. We speculate that this record may belong to *Mesobuthus*, and *Olivierus caucasicus* should thus be excluded from the list of Iraqi scorpions.

***Odontobuthus bidentatus* Lourenço & Pézier, 2002**

Pringle (1960) recorded *Odontobuthus doriae*, which was also listed by Khalaf (1963). Lourenço & Pézier (2002) described *O. bidentatus* from the west of the Zagros Mountains. *Odontobuthus doriae* is endemic to the central plateau region of Iran, but does not occur in Iraq leading us to exclude it from the list of scorpions in Iraq.

***Orthochirus mesopotamicus* (Birula, 1918) and *Orthochirus iraqus* Kovařík, 2004**

Penther (1912) recorded *Butheolus scrobiculosus* var. *persa* Birula, 1900, later reported as *Orthochirus scrobiculosus* in studies by Whittick (1955), Pringle (1960), Khalaf (1962) and Khalaf (1963). Vachon (1966), however, mentioned both *Orthochirus persa* (as a valid species, without any justification) and *O. scrobiculosus* (Grube, 1873). The latter is a name traditionally used for many *Orthochirus* populations from the Middle East and Central Asia. However, *O. scrobiculosus* was described from western Turkmenistan, and many of the known populations were misidentified. Kovařík (1992) reported *O. innesi* (Simon, 1910) from Iraq; later he corrected this and described it as a new species – *O. iraqus* Kovařík, 2004. Recently, Kovařík et al. (2019b) reviewed the *Orthochirus* fauna of Iraq; they elevated *O. scrobiculosus mesopotamicus* Birula, 1918 to species level and described a new species, *O. fomichevi*. In addition, they confirmed *O. iraqus* in Iraq. Each *Orthochirus* species in Iraq has a limited range, e.g. *O. fomichevi* is found in the north of the country and the foothills of Zagros Mountains, *O. iraqus* is found in the central and western plains, while *O. mesopotamicus* is found in southern humid and plain regions of Iraq. Therefore, we consider that all the previous records of *Orthochirus* in Iraq belong to the three above-mentioned species, while *Orthochirus innesi*, *O. scrobiculosus* and *O. persa* are excluded from the list of Iraqi scorpions. We reviewed again the record of *O. iraqus* by Al-Khazali & Yağmur (2019) from Dhi Qar Province and correct it to *O. mesopotamicus* herein.

***Razianus zarudnyi* (Birula, 1903)**

Razianus zarudnyi was described by Birula (1903) as *Hemibuthus zarudnyi* from Baluchistan, Persia (now Sistan and Baluchistan Provinces, Iran). Farzanpay (1987) erected the genus *Razianus* and transferred this species to the new genus. *Ra-*

zianus zarudnyi has been reported only from Iran for long time (Birula 1903, Vachon 1966, Farzanpay 1987, Navidpour et al. 2008a, 2008b, 2008c, 2008d, 2010, 2012, 2013, Piralikheirabadi et al. 2009, Karataş et al. 2012). Recently Tahir et al. (2014) confirmed it from Iran and recorded from Iraq.

Family Scorpionidae

Scorpio kruglovi Birula, 1910

Penther (1912) recorded *Scorpio maurus* var. *testaceus* from Iraq, a subspecies that was already synonymized by Birula (1910) with *S. maurus maurus*, which only occurs in northern Africa. In addition, Birula (1910) also described another subspecies, *S. maurus kruglovi* from Mosul and Deir-Zor, upper Euphrates (now Deir ez-Zor). Although Fet (2000) mentioned this locality as being in Iraq, it is now within the territory of Syria. This subspecies was recently elevated to species level as *Scorpio kruglovi* by Talal et al. (2015). Therefore, all records from Iraq seem to belong to *S. kruglovi*. Pringle (1960) reported *Scorpio maurus fuscus* from Sarsing (Dohuk Province), which is close to the type locality of *S. kruglovi*. Besides, Whittick (1955) already reported *S. maurus kruglovi* from Dohuk. Therefore, we accept the record of Pringle (1960) belongs to *S. kruglovi*, and *S. fuscus* is excluded from the list of scorpions from Iraq. Due to the known localities of *Scorpio* all being close to the type locality of *Scorpio kruglovi*, and this species was already recorded from Iraq, we accept all records as *S. kruglovi*.

Systematic list of the scorpions of Iraq

Data on the distribution of each scorpion species in Iraq are presented according to 18 administrative provinces.

Family Buthidae

In Iraq, the family Buthidae includes nine genera and 15 species (Tab. 1). The members of genera *Androctonus*, *Buthacus*, *Buthus*, *Hottentotta*, *Leiurus*, *Mesobuthus* and *Odontobuthus* are medically important species. Because they have effective neurotoxic venom they are dangerous for human health (Ward et al. 2018).

Androctonus bicolor (Ehrenberg, 1828)

Type locality and repository. Egypt; ZMH.

Distribution in Iraq. Dhi Qar Province (Al-Khazali & Yağmur 2019).

General distribution. Algeria, Egypt, Eritrea, Iraq, Israel, Jordan, Lebanon?, Libya, Morocco, Syria, Tunisia and Yemen (Al-Khazali & Yağmur 2019, Fet & Lowe 2000).

Androctonus crassicauda (Olivier, 1807)

Type locality and repository. Iran, Esfahan Province, Kashan; type lost.

Distribution in Iraq. *A. crassicauda* is one of the most widely distributed species in most provinces of Iraq. Basra, Babil, Dhi Qar, Maysan, Al-Qādisiyyah, Wasit, Najaf, Salah ad-Din, Karbala, Al Anbar, Baghdad, Diyala, Mosul, Erbil & Duhok Provinces (Whittick 1955, Pringle 1960, Khalaf 1962, Al-Ramahi & Al-Hasnawi 2012, Al-Azawi 2017, Al-Khazali & Yağmur 2019, Kachel 2020).

General distribution. Armenia, Azerbaijan, Bahrain, Egypt (Sinai), Iran, Iraq, Israel, Jordan, Kuwait, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates and Yemen (Fet & Lowe 2000, Hendrixson 2006).

Buthacus macrocentrus (Ehrenberg, 1828)

Type locality and repository. Egypt, Sinai; ZMB.

Distribution in Iraq. Mosul, Erbil, Najaf and Dhi Qar Provinces (Whittick 1955, Khalaf 1962, Khalaf 1963, Kovařík 2005, Mohammed et al. 2017, Al-Khazali & Yağmur 2019).

General distribution. Bahrain, Iran, Iraq, Israel, Jordan, Oman, Qatar, Saudi Arabia, Syria, Turkey, and United Arab Emirates (Crucitti & Vignoli 2002, Fet & Lowe 2000, Kovařík 2005, Lourenço 2006).

Buthus sp.

Distribution in Iraq. Baghdad Province (Kovařík 1992).

Note. Yet undescribed species (see above).

Compsobuthus jakesi Kovařík, 2003

Type locality and repository. Iraq, Najaf Province, Ash-Shabakah; FKCP.

Distribution in Iraq. Najaf Province (Kovařík 2003).

General distribution. Iran, Iraq (Kovařík 2003).

Compsobuthus matthiesseni (Birula, 1905)

Type locality and repository. Iran, Qum Province (= Qom); ZISP.

Distribution in Iraq. Baghdad, Diyala, Kirkuk, Erbil, Saladdin and Dhi Qar Provinces (Pringle 1960, Sissom & Fet 1998, Kovařík 2003, Al-Azawi 2018, Al-Khazali & Yağmur 2019).

General distribution. Iran, Iraq, Turkey, Syria (Birula 1905, Pringle 1960, Sissom & Fet 1998, Kovařík 1996, 2003).

Hottentotta mesopotamicus Lourenço & Qi, 2007

Type locality and repository. Iraq, Duhok Province, Zakho; MNHN.

Distribution in Iraq. Duhok and Diyala Provinces (Whittick 1955, Pringle 1960, Vachon 1966, Lourenço & Qi 2007).

General distribution. Iraq (Lourenço & Qi 2007).

Hottentotta saulcyi (Simon, 1880)

Type locality and repository. Iraq, Mosul; MNHN, ZMH.

Distribution in Iraq. Duhok, Mosul, Kirkuk, Sulaymaniyah, Diyala, Salah ad-Din and Baghdad Provinces (Pringle 1960, Khalaf 1962, Kovařík 2007, Ismael et al. 2018, Kachel 2020).

General distribution. Afghanistan, Iraq, Iran, Turkey (Birula 1918, Crucitti & Vignoli 2002, Kovařík 2007, Simon 1880).

Leiurus sp.

Distribution in Iraq. Salah ad-Din (Sissom, 1994, Shalita & Wells 2007).

Note. An unidentified species (see above).

Mesobuthus phillipsii (Pocock, 1889)

Type locality and repository. Iran, Bushehr Province, Bush-eher; BMNH.

Distribution in Iraq. Mosul, Salah ad-Din, Baghdad, Dhi Qar, Diyala, Babil and Basra Provinces (Penther 1912, Whittick 1955, Pringle 1960, Khalaf 1962, Vachon 1966, Morad & Al-Abbad 2016, Al-Azawi 2017, Al-Khazali & Yağmur 2019).

General distribution. Iran, Iraq, Turkey, Syria (Pocock 1889, Penther 1912, Kovařík et al. 2011).

***Odontobuthus bidentatus* Lourenço & Pézier, 2002**

Type locality and repository. Iraq, Baghdad, Khanaqin-Dyala; MHNG.

Distribution in Iraq. Mosul, Baghdad and Diyala Provinces (Pringle 1960, Khalaf 1963, Lourenço & Pézier 2002).

General distribution. Iran, Iraq (Lourenço & Pézier 2002).

***Orthochirus fomichevi* Kovařík, Yağmur, Fet & Hussien, 2019**

Type locality and repository. Iraq, Sulaymaniyah Province, Chaqzhi Khwaroo; FKCP.

Distribution in Iraq. Sulaymaniyah and Dohuk Provinces (Kovařík et al. 2019b).

General distribution. Iraq, Turkey (Kovařík et al. 2019b).

***Orthochirus mesopotamicus* (Birula, 1918)**

Type locality and repository. Iran, Khoozestan Province, Karun River, Kut-e-Gazaie; ZISP.

Distribution in Iraq. Wasit, Basra & Dhi Qar Provinces (Kovařík et al. 2019b, Al-Khazali & Yağmur 2019).

General distribution. Iran, Iraq (Kovařík et al. 2019b).

***Orthochirus iraqus* Kovařík, 2004**

Type locality and repository. Iraq, Najaf Province, Ash-Shabakah (Shabachah, Shabicha); FKCP.

Distribution in Iraq. Baghdad & Najaf Provinces (Kovařík 2004, Kovařík et al. 2019b).

General distribution. Iraq (Kovařík 2004, Kovařík et al. 2019b).

***Razianus zarudnyi* (Birula, 1903)**

Type locality and repository. Iran, Sistan and Baluchistan Province; ZISP.

Distribution in Iraq. Baghdad Province (Tahir et al. 2014).

General distribution. Iran, Iraq (Tahir et al. 2014).

Family Euscorpiidae

Euscorpius is the single genus of this family that has been reported in Iraq. *Euscorpius italicus* is distributed in separated regions. The reported population of this species in Iraq is assumed to be from a foreign source. Members of the family Euscorpiidae are not medically important species (Ward et al. 2018).

***Euscorpius italicus* (Herbst, 1800)**

Type locality and repository. Italy; type(s) lost.

Distribution in Iraq. Najaf Province (Fet & Kovařík 2003).

General distribution. Albania, Algeria, Croatia, Georgia, Greece, France, Hungary, Iraq, Italy, Monaco, Montenegro, Morocco, North Macedonia, Romania, Russia, San Marino, Slovenia, Switzerland, Tunisia, Turkey, Yemen (Fet & Sissom 2000, Fet & Kovařík 2003, Yağmur 2012).

Family Hemiscorpiidae

This family includes 16 species belonging to a single genus *Hemiscorpius*, which are distributed in the Middle East. The knowledge available on the venom components of one member of this family, *Hemiscorpius lepturus*, shows their medical significance (Monod & Lourenço 2005). Therefore, handling other species of Hemiscorpiidae should be done extremely carefully due to unknown venom composition.

***Hemiscorpius lepturus* Peters, 1861**

Type locality and repository. Iraq (Mendeli near Baghdad); ZMB.

Distribution in Iraq. Baghdad and Diyala Provinces (Monod & Lourenço 2005).

General distribution. Iran, Iraq (Peters 1861, Farzanpay 1987, Monod & Lourenço 2005).

Family Iuridae

The distribution of the family Iuridae is almost only limited to Greece and Turkey, with a single record in Iraq (Erbil); it requires further verification in Syria. Stings by the species of this family does not cause any harm to human health and such cases are also very rare. They have strong pedipalps for capturing prey.

***Calchas anlasi* Yağmur, Soleglad, Fet & Kovařík, 2013**

Type locality and repository. Turkey, Hakkari Province, Çukurca District; AZMM.

Distribution in Iraq. Erbil Province (Yağmur et al. 2013).

General distribution. Iraq, Turkey (Yağmur et al. 2013).

Family Scorpionidae

The family Scorpionidae includes only one genus in Middle East and North Africa which is *Scorpio*. The species *S. fuscus* (Ehrenberg, 1829), *S. kruglovi* Birula, 1910, *S. palmaris* (Ehrenberg, 1828), *S. propinquus* (Simon, 1872) and the subspecies *S. maurus arabicus* (Pocock, 1900) and *S. maurus towsendi* (Pocock, 1900) are known in the Middle East and Iran. Among these valid species only *S. kruglovi* Birula, 1910 was reported from Iraq. Members of the family Scorpionidae are not medically important species (Ward et al. 2018).

***Scorpio kruglovi* Birula, 1910**

Type locality and repository. Deir-Zor, upper Euphrates, now Syria; ZISP.

Distribution in Iraq. Mosul, Erbil, Duhok, Baghdad and Najaf Provinces (Penther 1912, Pringle 1960, Khalaf 1962, Sherwan 2015, Al-Azawi 2017, Mohammad et al. 2017, Kachel 2020).

General distribution. Iran, Iraq, Jordan, Kuwait, Qatar, Saudi Arabia, Syria (Fet 2000).

Discussion

Based on our revision, the Iraqi scorpion fauna consists of 19 species from 13 genera and five families: Buthidae, Euscorpiidae, Hemiscorpiidae, Iuridae and Scorpionidae. The majority of the species (15) belong to Buthidae, and the other families are represented by one species each. However, the Iraqi scorpion fauna is one of the least studied in the region, when compared to some neighbouring countries. Currently, 41 species and three subspecies from four families of scorpion are known from Turkey (Dupre 2016), 21 species in three families are known in Syria (Khalil & Yağmur 2010), 28 species are reported from Saudi Arabia (Al-Asmari et al. 2013) and 68 species in three families from Iran (Cokendolpher et al. 2019).

Identification of scorpion species based on morphological characters only, which are often inadequately described and illustrated, are the main taxonomic problem behind the continuous changes in scorpion classification (Sissom & Fet

Tab. 1: Distribution of the 18 accepted scorpion species in different provinces and regions of Iraq. Province numbers 1–18 are shown in Fig. 1. MR = Mountainous and highlands region, UR = Undulated and hilly, DR = Desert region, AR = Alluvial region

Family/species	Provinces/Geographical regions in Iraq																	
	MR			UR			DR						AR					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Buthidae																		
<i>Androctonus bicolor</i>																		
<i>Androctonus crassicauda</i>	■		■	■		■	■	■	■	■	■		■	■	■	■	■	■
<i>Buthacus macrocentrus</i>			■	■							■					■		
<i>Buthus</i> sp. (undescribed)								■										
<i>Compsobuthus jakesi</i>											■							
<i>Compsobuthus matthiesseni</i>			■		■	■		■	■							■		
<i>Hottentotta mesopotamicus</i>	■					■												
<i>Hottentotta saulcyi</i>	■	■		■	■	■		■	■									
<i>Leiurus</i> sp. (unidentified)									■									
<i>Mesobuthus phillipsii</i>				■		■		■	■							■	■	■
<i>Odontobuthus bidentatus</i>				■		■		■										
<i>Orthochirus fomichevi</i>	■	■																
<i>Orthochirus mesopotamicus</i>												■						■
<i>Orthochirus iraqus</i>								■			■					■		
<i>Razianus zarudnyi</i>								■										
Euscorpidae																		
<i>Euscorpis italicus</i>											■							
Hemiscorpiidae																		
<i>Hemiscorpius lepturus</i>						■		■										
Iuridae																		
<i>Calchas anlasi</i>			■															
Scorpionidae																		
<i>Scorpio kruglovi</i>	■		■	■				■			■							
Species number per province	5	2	5	6	2	7	1	8	4	1	6	0	2	1	1	6	2	2

1998). More detailed studies in the future will give us more accurate information about the true identity of some species. For example, *Orthochirus innesi* in Iraq was recorded by Kovařík (1992). Later this record was corrected by the same author (Kovařík 2005) to a new species, *O. iraqus*. In addition, several species have been recorded under different names or reported without verified confirmation for their existence in Iraq. Here, we excluded 18 species from the scorpion fauna of Iraq. To avoid such issues, a combination of morphology (chaetotaxy) and modern methods (molecular analyses) should be used for scorpion species identification (Dehghani & Kassiri 2018). It is also necessary that existing species should be properly redescribed, as Kovařík et al. (2019b) did for *Orthochirus mesopotamicus* and *Orthochirus iraqus*.

The geographical distribution of scorpion species in the four regions of Iraq is shown in Tab. 1. Three (*Androctonus crassicauda*, *Buthacus macrocentrus* and *Compsobuthus matthiesseni*) of the nineteen species are recorded in all four geographical regions. Buthidae – the most common and diverse family in Iraq – includes nine genera, *Androctonus*, *Buthacus*, *Buthus*, *Compsobuthus*, *Hottentotta*, *Leiurus*, *Odontobuthus*, *Orthochirus* and *Razianus*. The genera with the highest number of species recorded are *Hottentotta* and *Orthochirus* (three species each) (Tab. 1). Fourteen of the 19 species are recorded in DR which accounts for 74% of all scorpion diversity in Iraq. Recording of the large number of species in DR indicates that these species prefer desert habitats.

It is clear from the data presented in this review that seven of the 19 known species (*A. bicolor*, *Buthus* sp., *C. jakesi*, *Leiurus*

sp., *R. zarudnyi*, *E. italicus* and *C. anlasi*) have been reported from only one locality (Tab. 1) and most of them are identified from a very small number or even a single specimen. The data related to the single restricted geographical distribution of scorpion species in Iraq might be due to the inadequate number of scientific field studies rather than to restricted ecological conditions. Therefore, further investigation is required for confirmation of their presence and geographical distribution in Iraq, especially in western and southwestern regions.

On the other hand, twelve species (*A. crassicauda*, *B. macrocentrus*, *C. matthiesseni*, *H. mesopotamicus*, *H. saulcyi*, *M. phillipsii*, *O. bidentatus*, *O. fomichevi*, *O. mesopotamicus*, *O. iraqus*, *H. lepturus* and *S. kruglovi*) have wider geographical distribution in two or more regions and provinces throughout the country and appear to be adapted to different habitats (Mirshamsi 2013). *Androctonus crassicauda* is widespread in Iran, Syria, Turkey, Jordan and Saudi Arabia, and is the most frequently reported species in Iraq (Ozkan et al. 2006, Navidpour et al. 2012). It has been recorded from 15 provinces out of 18 in Iraq. *Compsobuthus matthiesseni*, *H. saulcyi*, *M. phillipsii*, *O. fomichevi* and *S. kruglovi* may be noted as other species which are widespread in Iraq.

Lack of detailed epidemiological and biochemical studies on the scorpions of Iraq are the main reasons behind unknown dangerously venomous and medical important species. Based on international studies, *H. lepturus*, *A. crassicauda*, *A. bicolor* and *H. saulcyi* are considered venomous and medically important scorpion species from Iraq (Keegan 1980). Beside *H. lepturus* from the family Hemiscorpiidae, reportedly the

most dangerous and medically important scorpion species in Iraq, all other hazardous scorpion species belong to the family Buthidae. *Hemiscorpius lepturus* is generally found in the Baghdad and Diyala provinces in Iraq. It is also found in Yemen and Pakistan (Rein 2020). *Hemiscorpius lepturus* is known to cause 95% of patient deaths by scorpion stings in Iran (Radmanesh 1990). Therefore, educating health staff and communities with the necessary knowledge on the morphology and ecology of the known scorpion species in Iraq might lead to significant reduction in the rate of scorpion stings. In addition, this work might lead to future studies on the bioactive molecules within their venom for better understanding their modes of action and developing species-specific anti venom.

Acknowledgements

We would like to thank Victor Fet, Gérard Dupre and Graeme Lowe for providing us with the required papers and information. Special thanks to Victor Fet for his very extensive and complex review and assistance in manuscript English editing.

References

- Al-Asmari AK, Al-Saif AA, Abdo NM, Al-Moutaery KR, Al-Harbi NO 2013 A review of the scorpion fauna of Saudi Arabia. – Egyptian Journal of Natural History 6: 1-21 – doi: [10.4314/ejnh.v6i1.1](https://doi.org/10.4314/ejnh.v6i1.1)
- Al-Azawi ZNN 2017 List of scorpions recorded for the first time in Iraq. – Ibn Al-Haitham Journal for Pure and Applied Science 29 (2016): 49-57
- Al-Azawi ZN 2018 Description of new species of scorpions *Compsobuthus iraqensis* (Arachnida: Buthidae) for the first time in Iraq and world. – Iraqi Journal of Agricultural Sciences 49: 708-721 – doi: [10.36103/ijas.v49i4.81](https://doi.org/10.36103/ijas.v49i4.81)
- Al-Khazali A & Yağmur E 2019 First record of *Androctonus bicolor* Ehrenberg, 1828 (Arachnida: Scorpiones) with scorpion records Dhi Qar Province, Iraq. – Biharean Biologist 13: 85-88
- Al-Ramahi H & Al-Hasnawi M 2012 Diagnostic and epidemiologic study of fat tail scorpion (*Androctonus crassicauda*) in Mid-Euphrates region/Iraq. – Journal of Kerbala University 10: 263-269
- Bachmann A, Chappell B, Elliott N & Matti N (eds.) 2011 Key biodiversity survey of Iraq, 2010 site review. Nature Iraq & Iraq Ministry of Environment, Sulaimani, Kurdistan, Iraq. 100 pp. – doi: [10.13140/RG.2.2.29639.85923](https://doi.org/10.13140/RG.2.2.29639.85923)
- Birula A 1903 Beiträge zur Kenntniss der Scorpionenfauna Ost-Persiens. (2. Beitrag). – Bulletin de l'Académie Impériale des Sciences de St.-Petersbourg 19: 67-80
- Birula A 1905 Beiträge zur Kenntniss der Scorpionenfauna Persiens (Dritter Beitrag). – Bulletin de l'Académie impériale des sciences de St.-Petersbourg 23: 119-148
- Birula A 1910 Über *Scorpio maurus* Linné und seine Unterarten. – Horae Societatis Entomologicae Rossicae 39: 115-192
- Birula A 1918 Miscellanea scorpologica. XI. Contributions to the knowledge of scorpions of outer Mesopotamia, Kurdistan and North Persia. – Annuaire du Musée Zoologique de l'Académie des Sciences de Russie 22: 1- 44 (in Russian)
- Cokendolpher J, Zamani A & Snegovaya N 2019 Overview of arachnids and arachnology in Iran. – Journal of Insect Biodiversity and Systematics 5: 301-367
- Corkhill N 1930 Some notes on scorpions in Iraq. – Journal of the Bombay Natural History Society 34: 265-267
- Crucitti P & Vignoli V 2002 Gli scorpioni (Scorpiones) dell'Anatolia sud-orientale (Turchia). – Bollettino della Museo regionale di Scienze naturali Torino 19: 433-474
- Dehghani R & Kassiri H 2018 A checklist of scorpions in Iran (by 2017). – Asian Journal of Pharmaceutics 12: 880-887 – doi: [10.22377/ajp.v12i03.2623](https://doi.org/10.22377/ajp.v12i03.2623)
- Dupré G 2016 Les scorpions de Turquie. – Arachnides 79: 1-14
- Farzanpay R 1987 [Knowing scorpions]. Central University Publications 312, Biology 4, Teheran. 231 pp. [in Farsi, with Latin index]
- Fet V 2000 Family Scorpionidae Latreille, 1802. In: Fet V, Sissom WD, Lowe G & Braunwalder ME (eds) Catalog of the scorpions of the world (1758–1998). New York Entomological Society, New York. pp. 427-486
- Fet V & Lowe G 2000 Family Buthidae. In: Fet V, Sissom WD, Lowe G & Braunwalder ME (eds.) Catalog of the scorpions of the world (1758–1998). New York Entomological Society, New York. pp. 54-286
- Fet V & Kovařík F 2003 First record of *Euscorpius (Polytrichobothrius) italicus* (Scorpiones: Euscorpiidae) from Iraq. – Acta Societatis Zoologicae Bohemicae 67: 179-181
- Fet V & Sissom WD 2000 Family Euscorpiidae. In: Fet V, Sissom WD, Lowe G & Braunwalder ME (eds) Catalog of the scorpions of the world (1758–1998). New York Entomological Society, New York. pp. 355-381
- Fet V, Soleglad ME & Kovařík F 2009 Etudes on iurids, II. Revision of genus *Calchas* Birula, 1899, with the description of two new species (Scorpiones: Iuridae). – Euscorpius 82:1-72 – doi: [10.18590/euscorpius.2009.vol2009.iss82.1](https://doi.org/10.18590/euscorpius.2009.vol2009.iss82.1)
- Gantenbein B, Fet V & Gromov A 2003 The first DNA phylogeny of four species of *Mesobuthus* Vachon, 1950 (Scorpiones, Buthidae) from Eurasia. – Journal of Arachnology 31: 412-420 – doi: [10.1636/H01-23](https://doi.org/10.1636/H01-23)
- Hendrixson BE 2006 Buthid scorpions of Saudi Arabia, with notes on other families (Scorpiones: Buthidae, Liochelidae, Scorpionidae). – Fauna of Arabia 21: 33-120
- Ismael B, Abass K, Khalil K & Salih K 2018 Preparation of F (ab') 2 antivenom in Iraq against scorpion (*Hottentotta saulcyi*) venom. – Biologicals 56: 19-23 – doi: [10.1016/j.biologicals.2018.08.005](https://doi.org/10.1016/j.biologicals.2018.08.005)
- Kachel H 2020 Scorpion fauna and scorpionism in Zakho Province of Northern Iraq. – Commagene Journal of Biology 4: 22-27 – doi: [10.31594/commagene.710923](https://doi.org/10.31594/commagene.710923)
- Keegan HL 1980 Scorpions of medical importance. University Press of Mississippi, Jackson/Mississippi. 140 pp.
- Kennedy W 1937 Some additions to the fauna of Iraq. – Journal of the Bombay Natural History Society 39: 745-749
- Khalaf K 1963 Scorpions reported from Iraq. – Bulletin of Endemic Diseases (Baghdad) 5: 59-70
- Khalaf L 1962 A small collection of scorpions from Iraq. – Bulletin of the Iraq Natural History Institute 4: 1-3
- Khalil N & Yağmur EA 2010 *Leiurus abdullabbayrami* (Scorpiones: Buthidae), a new species for the scorpion fauna of Syria – Serket 12: 1-6
- Kovařík F 1992 *Buthus occitanus* (Amoreuxi, 1789) and *Orthochirus innesi* Simon, 1910 (Scorpionidea: Buthidae) from Iraq. – Časopis Národního Muzea, Řada přírodovědná 159: 90
- Kovařík F 1996 First report of *Compsobuthus matthiesseni* (Scorpiones: Buthidae) from Turkey. – Klapalekiana 32: 53-55
- Kovařík F 2003 Eight new species of *Compsobuthus* Vachon, 1949 from Africa and Asia (Scorpiones: Buthidae). – Serket 8: 87-112
- Kovařík F 2004 Revision and taxonomic position of genera *Afghanorthochirus* Lourenço & Vachon, *Baloorthochirus* Kovařík, *Butheolus* Simon, *Nanobuthus* Pocock, *Orthochiroides* Kovařík, *Pakistanorthochirus* Lourenço, and Asian *Orthochirus* Karsch, with descriptions of twelve new species (Scorpiones, Buthidae). – Euscorpius 16: 1-33 – doi: [10.18590/euscorpius.2004.vol2004.iss16.1](https://doi.org/10.18590/euscorpius.2004.vol2004.iss16.1)
- Kovařík F 2005 Taxonomic position of species of the genus *Buthacus* Birula, 1908 described by Ehrenberg and Lourenço, and description of a new species (Scorpiones: Buthidae). – Euscorpius 28: 1-13 – doi: [10.18590/euscorpius.2005.vol2005.iss28.1](https://doi.org/10.18590/euscorpius.2005.vol2005.iss28.1)
- Kovařík F 2007 A revision of the genus *Hottentotta* Birula, 1908, with descriptions of four new species (Scorpiones, Buthidae). – Euscorpius 58: 1-107 – doi: [10.18590/euscorpius.2007.vol2007.iss58.1](https://doi.org/10.18590/euscorpius.2007.vol2007.iss58.1)
- Kovařík F 2019 Taxonomic reassessment of the genera *Lychas*, *Mesobuthus*, and *Olivierus*, with descriptions of four new genera (Scorpiones: Buthidae). – Euscorpius 288: 1-27 – doi: [10.18590/euscorpius.2019.vol2019.iss288.1](https://doi.org/10.18590/euscorpius.2019.vol2019.iss288.1)
- Kovařík F & Ojanguren Affilastro A 2013 Illustrated catalog of scorpions. Part II. Bothriuridae; Chaerilidae; Buthidae I. Genera

- Compsobuthus*, *Hottentotta*, *Isometrus*, *Lychas*, and *Sassanidotus*. Clairon Production, Praha. 400 pp.
- Kovařík F, Yağmur EA & Fet V 2019a Review of *Hottentotta* described by A. A. Birula, with descriptions of two new species and comments on Birula's collection (Scorpiones: Buthidae). – *Euscorpius* 282: 1-30 – doi: [10.18590/euscorpius.2019.vol2019.iss282.1](https://doi.org/10.18590/euscorpius.2019.vol2019.iss282.1)
- Kovařík F, Yağmur EA, Fet V & Hussen F 2019b A review of *Orthochirus* from Turkey, Iraq, and Iran (Khoozestan, Ilam, and Lorestan Provinces), with descriptions of three new species (Scorpiones: Buthidae). – *Euscorpius* 278: 1-31 – doi: [10.18590/euscorpius.2019.vol2019.iss278.1](https://doi.org/10.18590/euscorpius.2019.vol2019.iss278.1)
- Kovařík F, Yağmur EA, Fet V & Navidpour S 2011 On two subspecies of *Mesobuthus eupeus* (C. L. Koch, 1839) in Turkey (Scorpiones: Buthidae). – *Euscorpius* 109: 1-15 – doi: [10.18590/euscorpius.2011.vol2011.iss109.1](https://doi.org/10.18590/euscorpius.2011.vol2011.iss109.1)
- Kraepelin K 1899 Scorpiones und Pedipalpi. In: Dahl F (ed.) *Das Tierreich* 8. Friedländer und Sohn, Berlin. 265 pp.
- Levy G, Amitai P & Shulov A 1973 New scorpions from Israel, Jordan and Arabia. – *Zoological Journal of the Linnean Society* 52: 113-140 – doi: [10.1111/j.1096-3642.1973.tb00782.x](https://doi.org/10.1111/j.1096-3642.1973.tb00782.x)
- Lourenço WR 2006 Further considerations on the genus *Buthacus* Birula, 1908. – *Boletín Sociedad Entomológica Aragonesa* 1: 59-70
- Lourenço WR 2020 First record and description of a new species of *Leiurus* Ehrenberg from Kuwait (Scorpiones: Buthidae). – *Serket* 17: 143-149
- Lourenço WR & Pézier A 2002 Taxonomic consideration of the genus *Odontobuthus* Vachon (Scorpiones, Buthidae), with description of a new species. – *Revue suisse de Zoologie* 109: 115-125 – doi: [10.5962/bhl.part.79581](https://doi.org/10.5962/bhl.part.79581)
- Lourenço WR & Qi J-X 2007 Description of a new species of the genus *Hottentotta* Birula, 1908 (Scorpiones: Buthidae) from Iraq. – *Zoology in the Middle East* 41: 99-104 – doi: [10.1080/09397140.2007.10638232](https://doi.org/10.1080/09397140.2007.10638232)
- Lourenço WR, Leguin EA & Duhem B 2010 Notes on the type material of *Compsobuthus acutecarinatus* (Simon, 1882) and *C. maindroni* (Kraepelin, 1900), and description of a new species from United Arab Emirates: (Scorpiones: Buthidae). – *Zoology in the Middle East* 50: 119-126
- Lowe G, Yağmur EA & Kovařík F 2014 A review of the genus *Leiurus* Ehrenberg, 1828 (Scorpiones: Buthidae) with description of four new species from the Arabian Peninsula. – *Euscorpius* 191: 1-129 – doi: [10.18590/euscorpius.2014.vol2014.iss191.1](https://doi.org/10.18590/euscorpius.2014.vol2014.iss191.1)
- Malinowski JC (ed.) 2002 Iraq: a geography. U.S. Military Academy, West Point. 120 pp. – Internet: <http://files.eric.ed.gov/fulltext/ED476013.pdf> (25. May 2020)
- Mirshamsi O 2013 Ecological niche modeling of two scorpion species *Mesobuthus eupeus* (C. L. Koch, 1839) and *M. phillipsii* (Pocock, 1889) from the Iranian Plateau and Zagros region (Arachnida: Scorpiones). – *Euscorpius* 154: 1-10 – doi: [10.18590/euscorpius.2013.vol2013.iss154.1](https://doi.org/10.18590/euscorpius.2013.vol2013.iss154.1)
- Mirshamsi O, Sari A, Elahi E & Hosseinie S 2011 *Mesobuthus eupeus* (Scorpiones: Buthidae) from Iran: a polytypic species complex. – *Zootaxa* 2929: 1-21 – doi: [10.11646/zootaxa.2929.1.1](https://doi.org/10.11646/zootaxa.2929.1.1)
- Mohammad KM, Afrasiab SR, Al-Zubaidi AA & Abdul-Rassoul MS 2017 Survey for cave animals of Iraqi Kurdistan. – *Journal of Biodiversity and Environmental Sciences* 10: 217-232
- Mohammed R, Rhadi F, Rastegar-Pouyani N, Rastegar-Pouyani E & Yousefkhani S 2017 Zoogeography of lizards fauna from central and southern Iraq with a checklist of Iraqi lizard's fauna. – *Russian Journal of Herpetology* 24: 193-201 – doi: [10.30906/1026-2296-2019-24-3-193-201](https://doi.org/10.30906/1026-2296-2019-24-3-193-201)
- Monod L & Lourenço W 2005 Hemiscorpiidae (Scorpiones) from Iran, with descriptions of two new species and notes on biogeography and phylogenetic relationships. – *Revue suisse de Zoologie* 112: 869-941 – doi: [10.5962/bhl.part.80331](https://doi.org/10.5962/bhl.part.80331)
- Morad MSS & Al-Abbad MYM 2016 Identification study for the scorpion *Mesobuthus phillipsii* (Pocock, 1889) (Scorpiones: Buthidae) from Basrah province, southern Iraq. – *Basra Journal of Science* 43: 50-73
- Navidpour S, Fet V, Kovařík F & Soleglad ME 2008a Scorpions of Iran (Arachnida, Scorpiones). Part III. Ilam Province. – *Euscorpius* 69: 1-29 – doi: [10.18590/euscorpius.2008.vol2008.iss69.1](https://doi.org/10.18590/euscorpius.2008.vol2008.iss69.1)
- Navidpour S, Fet V, Kovařík F & Soleglad ME 2012 Scorpions of Iran (Arachnida: Scorpiones). Part VIII. Fars Province. – *Euscorpius* 139: 1-31 – doi: [10.18590/euscorpius.2012.vol2012.iss139.1](https://doi.org/10.18590/euscorpius.2012.vol2012.iss139.1)
- Navidpour S, Kovařík F, Soleglad ME & Fet V 2008b Scorpions of Iran (Arachnida, Scorpiones). Part I. Khoozestan Province. – *Euscorpius* 65: 1-41 – doi: [10.18590/euscorpius.2008.vol2008.iss65.1](https://doi.org/10.18590/euscorpius.2008.vol2008.iss65.1)
- Navidpour S, Kovařík F, Soleglad ME & Fet V 2008c Scorpions of Iran (Arachnida, Scorpiones). Part IV. Kohgiluyeh & Boyer Ahmad Province. – *Euscorpius* 74: 1-24 – doi: [10.18590/euscorpius.2008.vol2008.iss74.1](https://doi.org/10.18590/euscorpius.2008.vol2008.iss74.1)
- Navidpour S, Nayebzadeh HH, Soleglad ME, Fet V, Kovařík F & Kayedi MH 2010 Scorpions of Iran (Arachnida, Scorpiones). Part VI. Lorestan Province. – *Euscorpius* 99: 1-23 – doi: [10.18590/euscorpius.2010.vol2010.iss99.1](https://doi.org/10.18590/euscorpius.2010.vol2010.iss99.1)
- Navidpour S, Soleglad ME, Fet V & Kovařík F 2008d Scorpions of Iran (Arachnida, Scorpiones). Part II. Bushehr Province. – *Euscorpius* 67: 1-33 – doi: [10.18590/euscorpius.2008.vol2008.iss67.1](https://doi.org/10.18590/euscorpius.2008.vol2008.iss67.1)
- Navidpour S, Soleglad ME, Fet V & Kovařík F 2013 Scorpions of Iran (Arachnida, Scorpiones). Part IX. Hormozgan Province, with a description of *Odontobuthus tavighiae* sp. n. (Buthidae). – *Euscorpius* 170: 1-29 – doi: [10.18590/euscorpius.2013.vol2013.iss170.1](https://doi.org/10.18590/euscorpius.2013.vol2013.iss170.1)
- Ozkan O, Adigüzel S, Yakiştiran S, Cesaretli Y, Orman M & Karaer K 2006 *Androctonus crassicauda* (Olivier 1807) scorpionism in the Sanliurfa province of Turkey. – *Türkiye Parazitoloji Dergisi* 30: 239-245
- Penther A 1912 Wissenschaftliche Ergebnisse der Expedition nach Mesopotamien 1910. Scorpiones. – *Annalen des Kaiserlich-Königlichen Naturhistorischen Hofmuseums in Wien* 26: 109-116
- Peters W 1861 Eine neue Untergattung von Skorpionen. – *Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin* 1861: 426-427
- Pocock RI 1889 Notes on some Buthidae, new and old. – *Annals and Magazine of Natural History* (6) 3: 334-351 – doi: [10.1080/00222938909460342](https://doi.org/10.1080/00222938909460342)
- Pirali-Kheirabadi K, Navidpour S, Fet V, Kovařík F & Soleglad ME 2009 Scorpions of Iran (Arachnida, Scorpiones). Part V. Chahar Mahal & Bakhtiari Province. – *Euscorpius* 78: 1-23 – doi: [10.18590/euscorpius.2009.vol2009.iss78.1](https://doi.org/10.18590/euscorpius.2009.vol2009.iss78.1)
- Pringle G 1960 Notes on the Scorpiones of Iraq. – *Bulletin of Endemic Diseases (Baghdad)* 3: 73-87
- Radmanesh M 1990 Surveying scorpion sting in general. – *Darou va Darman Journal* 8: 26-30
- Rein JO 2020 The scorpion files. – <https://www.ntnu.no/ub/scorpion-files> (25. May 2020)
- Shalita E & Wells R 2007 Treatment of yellow scorpion (*Leiurus quinquestriatus*) sting: a case report. – *Journal of the American Pharmacists Association* 47: 616-619 – doi: [10.1331/JAPhA.2007.07051](https://doi.org/10.1331/JAPhA.2007.07051)
- Sherwan T 2015 Morphology and histology of venom gland of *Scorpio maurus kruglovi* (Birula, 1910) (Scorpionidae: Scorpiones). – *Zanco Journal of Pure and Applied Sciences* 27: 59-62
- Simon E 1880 Descriptions de genres et espèces de l'ordre des Scorpiones. – *Annales de la Société Entomologique de France* (5) 10: 377-398
- Sissom WD 1994 Descriptions of new and poorly known scorpions of Yemen (Scorpiones: Buthidae, Diplocentridae, Scorpionidae). – *Fauna of Saudi Arabia* 14: 3-39
- Sissom WD & Fet V 1998 Redescription of *Compsobuthus matthieseni* (Birula, 1905) (Scorpiones, Buthidae) from Southwestern Asia. – *Journal of Arachnology* 26: 1-8
- Sousa P, Arnedo M & Harris DM 2017 Updated catalogue and taxonomic notes on the Old-World scorpion genus *Buthus* Leach, 1815 (Scorpiones, Buthidae). – *ZooKeys* 686: 15-84 – doi: [10.3897/zookeys.686.12206](https://doi.org/10.3897/zookeys.686.12206)
- Tahir HM, Navidpour S & Prendini L 2014 First reports of *Razianus* (Scorpiones: Buthidae) from Iraq and Pakistan, descriptions of two new species, and redescription of *Razianus zarudnyi*. – *American Museum Novitates* 3806: 1-26 – doi: [10.1206/3806.1](https://doi.org/10.1206/3806.1)

- Talal S, Tesler I, Sivan J, Ben-Shlomo R, Tahir H, Prendini L, Snir S & Gefen E 2015 Scorpion speciation in the Holy Land: Multilocus phylogeography corroborates diagnostic differences in morphology and burrowing behavior among *Scorpio* subspecies and justifies recognition as phylogenetic, ecological and biological species. – *Molecular Phylogenetics and Evolution* 91: 226-237 – doi: [10.1016/j.ympev.2015.04.028](https://doi.org/10.1016/j.ympev.2015.04.028)
- Vachon M 1966 Liste des scorpions connus en Égypte, Arabie, Israël, Liban, Syrie, Jordanie, Turquie, Irak, Iran. – *Toxicon* 4: 209-218 – doi: [10.1016/0041-0101\(66\)90052-3](https://doi.org/10.1016/0041-0101(66)90052-3)
- Vachon M & Kinzelbach R 1987 On the taxonomy and distribution of the scorpions of the Middle East. In: Krupp F, Schneider W & Kinzelbach R (eds) *Proceedings of the Symposium on the Fauna and Zoogeography of the Middle East*, Mainz, 1985. – *Beihefte zum Tübinger Atlas des Vorderen Orients A (Naturwissenschaften)* 28: 91-103
- Ward MJ, Ellsworth SA & Nystrom GS 2018 A global accounting of medically significant scorpions: Epidemiology, major toxins, and comparative resources in harmless counterparts. – *Toxicon* 151: 137-155 – doi: [10.1016/j.toxicon.2018.07.007](https://doi.org/10.1016/j.toxicon.2018.07.007)
- Whittick RJ 1955 Scorpions from Palestine, Syria, Iraq and Iran. In: Field H (ed.) *Contributions to the fauna and flora of Southwestern Asia. Miscellanea Asiatica Occidentalis XII*. Privately printed by Henry Field, Coconut Grove, Florida. pp. 76-81
- Yağmur EA 2012 First record of the genus *Euscorpius* Thorell, 1876 (Scorpiones: Euscorpiidae) in Cyprus. – *Acta zoologica bulgarica* 64: 329-330
- Yağmur EA, Soleglad M, Fet V & Kovařík V 2013 Etudes on iurids, VI. Further revision of *Calchas* Birula, 1899 (Scorpiones: Iuridae), with a description of a new genus and two new species. – *Euscorpius* 159: 1-37 – doi: [10.18590/euscorpius.2013.vol2013.iss159.1](https://doi.org/10.18590/euscorpius.2013.vol2013.iss159.1)
- Zhang X, Liu G, Feng Y, Zhang D & Shi C 2020 Genetic analysis and ecological niche modeling delimit species boundary of the Przewalski's scorpion (Scorpiones: Buthidae) in arid Asian inland. – *Zoological Systematics* 45: 81-96 – doi: [10.11865/zs.202013](https://doi.org/10.11865/zs.202013)