

Bioecology and Systematic of Scorpions in Southwestern Anatolia Region (Arachnida: Scorpiones)

Fatih YEŞİLYURT^{1*}, İrfan ALBAYRAK²

¹*Yüksekova Vocational School, Hakkari University, Yüksekova, Hakkari, Turkey*

²*Kırkkale University*

(ORCID: [0000-0002-4181-6546](https://orcid.org/0000-0002-4181-6546))(ORCID: [0000-0002-0791-9584](https://orcid.org/0000-0002-0791-9584))



Keywords: Scorpion,
Zoogeography, Systematic,
Southwestern Anatolia, Turkey.

Abstract

In this study, scorpion fauna from six provinces in the Southwestern Anatolia Region (Antalya, Aydın, Burdur, Denizli, Isparta, and Muğla) of Turkey was studied, and 11 species in 6 genera belonging to 3 families were recorded. Examined specimens were collected between May 2006 and September 2011 from several provinces of the research field in the Southwestern Anatolia Region. As a result of field trips, 342 specimens were collected. Besides, some museum materials that were previously collected were used. At the end of the studies, it was determined that *Aegaeobuthus gibbosus*, *Anatoliurus kraepelini*, *Euscorpius arikani*, *E. avcii*, *E. gocmeni*, *E. honazicus*, *E. lycius*, *E. sultanensis*, *Iurus kinzelbachi*, *Metaiurus kadleci*, and *Neocalchas gruberi* species are distributed in the Southwestern Anatolia Region of Turkey. Among these samples, *Neocalchas gruberi* species was recorded from Isparta province, *Euscorpius arikani* was recorded from Muğla province, *E. honazicus* species was recorded from Burdur province, and *E. sultanensis* species was recorded from Isparta province, *Anatoliurus kraepelini* species was recorded from Isparta and Denizli provinces for the first time. In this study, the systematic, bioecologic, and faunistic information of the determined species were presented, besides ecological and biological field trip notes.

1. Introduction

Turkey's geographical location, climate, and flora have made rich faunal elements available. To determine the biodiversity values of our country, more detailed scientific studies will be required. In the scorpion of our country, which is a peninsula, when we look at the fauna, it is seen that some species are endemic and some of them are species originating from Central Asia, the Middle East, the Caucasus, and Europe.

Yağmur (2022) reported that 41 species belonging to 4 families (Buthidae, Euscorpiidae, Iuridae, and Scorpionidae) live in Turkey [1]. Parmakelis et al. (2022), based on their findings, established three new genera of Iurinae (*Metaiurus*, *Anatoliurus*, and *Letoiurus*), and a new record of *Letoiurus rhodiensis* was given from Turkey [2]. Kovařík et al. (2022) revised the genus *Mesobuthus* Vachon (1950) and

described 14 new species [3]. Of these, *M. rahsena*, *M. Turcicus*, and *M. yagmuri* are included in the scorpion fauna of Turkey. In addition, it was stated in the same publication that the species known as *M. phillipsii* was *M. mesopotamicus*.

Von Ubisch (1922) described the *Iurus kraepelini* species from Finike (Antalya) [4]. Schenkel (1947) described the *Mesobuthus gibbosus anatolicus* subspecies from Sivas and Amasya [5]. *Aegaeobuthus gibbosus anatolicus* was described under the [protonym](#) *Buthus gibbosus* by Brullé in 1832 [6]. It was placed in the genus *Mesobuthus* by Vachon in 1950 [7], then in the genus *Aegaeobuthus* by Kovařík in 2019 [8]. Fet et al. (2009) made a revision on the genus *Calchas* and included *C. gruberi* and *C. birulai* [9]; Kovařík et al. (2010) re-examined the genus *Iurus* and described two new species, *Iurus kadleci* and *Iurus kinzelbachi*, in Turkey [10]. *Iurus kraepelini*, which is found in the south of Turkey and used as a

*Corresponding author fatihyesilyurt@hakkari.edu.tr

Received: 15.02.2023, Accepted: 07.06.2023

synonym of *Iurus asiaticus*, was used as a species, and it was stated that *Iurus asiaticus* was found in Eastern Anatolia. Soleglad et al. (2012), with the revision of *Iurus*, identified *Iurus* species found in Anatolia according to the angle of hemispermatophores and divided them into *Protoiurus* and *Iurus* [11]. Tropea et al. (2012) identified a new scorpion species named *Euscorpium* (*Euscorpium*) *avcii* in the Dilek Peninsula of Aydın province [12]. Yağmur et al. (2013a) described a new scorpion species, *E. lycius*, from Muğla and Antalya provinces [13]. Yağmur et al. (2013b) identified a new scorpion genus, *Neocalchas*, from Turkey [14]. Tropea et al. (2014) identified a new scorpion species, *Euscorpium gocmeni*, from Antalya province (Akseki district) [15]. Yağmur and Tropea (2015) identified a new scorpion species, *E. Arikani*, from Antalya province [16]. Yağmur et al. (2015a) described a new scorpion species, *Protoiurus kumlutasi*, from Antalya (Hidirellez Cave) [17]. Yağmur et al. (2015b) analyzed iurids, and new information is presented on the morphometric differences between adult and immature males of *Metaiurus kadleci* and the differences between *M. kadleci* and other *Protoiurus* species. An updated identification of *M. kadleci*, as well as an updated key to other species and a map showing all known settlements, are presented [18]. Tropea and Yağmur (2016a) identified a new scorpion species, *Euscorpium sultanensis*, from the Sultan Mountains [19]. Tropea and Yağmur (2016b) described a new scorpion species, *E. Hakani*, from Denizli [20]. Tropea et al. (2016a) identified a new scorpion species, *E. honazicus*, from Denizli province (Honaz Mountain) [21]. Tropea et al. (2016b) identified a new scorpion species, *E. Alanyaensis*, from Antalya province (Taurus Mountains Alanya side) [22]. The specimens collected by R. Kinzelbach in Turkey in the 1970s and found in the Mainz Naturhistorisches Museum (Germany) were analyzed by Yağmur (2021a). According to the current taxonomy, one “*Euscorpium carpathicus*” specimen from İzmir was identified as *E. avcii*; two “*E. carpathicus*” specimens from Mersin were identified as *E. koci* [23]. Cain et al. (2021) made a revision study on the genus *Buthacus* of Israel and surrounding regions and stated that the species known as *Buthacus macrocentrus* in Turkey is *Buthacus tadmorensis* [24].

As a result of all these studies, the scorpion fauna of Turkey is currently represented by 46 species: *Aegaeobuthus gibbosus anatolicus*, *A. nigrocinctus*, *Alpiscorpium mingrelicus*, *A. phrygius*, *A.* region and examined by the author, the total number of samples reaches 342.

uludagensis, *Anatoliurus kraepelini*, *A. kumlutasi*, *Androctonus turkiyensis*, *Buthacus tadmorensis*, *Calchas anlasi*, *C. birulai*, *C. kosswigi*, *C. nordmanni*, *Compsobuthus matthiesseni*, *C. schmiedeknechti*, *Euscorpium aladaglarenensis*, *E. alanyaensis*, *E. arikani*, *E. avcii*, *E. ciliciensis*, *E. eskisehirensis*, *E. gocmeni*, *E. hakani*, *E. honazicus*, *E. idaeus*, *E. italicus*, *E. koci*, *E. lesbiacus*, *E. lycius*, *E. sultanensis*, *E. tauricus*, *Hottentotta saulcyi*, *Iurus kinzelbachi*, *Leiurus abdullahbayrami*, *Letoiurus rhodiensis*, *Mesobuthus eupeus*, *M. mesopotamicus*, *M. rahsenae*, *M. turcicus*, *M. yagmuri*, *Metaiurus kadleci*, *Neocalchas gruberi*, *Olivierus caucasicus*, *Orthochirus fomichevi*, *Protoiurus asiaticus*, *Scorpio fuscus* (Cain et al., 2021; Yağmur, 2022; Kovařík et al., 2022; Parmakelis et al., 2022).

Of these species, *Aegaeobuthus gibbosus anatolicus*, *Anatoliurus kraepelini*, *A. kumlutasi*, *Euscorpium alanyaensis*, *E. arikani*, *E. avcii*, *E. gocmeni*, *E. hakani*, *E. honazicus*, *E. lycius*, *E. sultanensis*, *Iurus kinzelbachi*, *Metaiurus kadleci*, and *Neocalchas gruberi*, constitute the species found in the study area. The Southwestern Anatolia Region of Turkey (Antalya, Aydın, Burdur, Denizli, Isparta, and Muğla) is specifically investigated in this study. Therefore, the present study attempted to facilitate knowledge of the distribution of Turkish Scorpion fauna.

2. Material and Method

2.1. Location and characteristics of the research region

The sample collection area is between 27° 23' - 32° 27' east longitudes and 36° 06' - 38° 30' north latitudes in Southwest Anatolia. Within this selected region, there are the provinces of Antalya, Aydın, Burdur, Denizli, Isparta, and Muğla (Figure 3.1). Of these, Antalya, Burdur, and Isparta are located in the Mediterranean Region, while Aydın, Denizli, and Muğla are located in the Aegean Region.

2.2. Collection and evaluation of material

The majority of the samples examined in this study were collected from the Southwest Anatolia Region (Antalya, Aydın, Burdur, Denizli, Isparta, and Muğla) between May 2006 and September 2011. As a result of field studies, 259 samples from various localities were examined. However, with the samples collected by the author between 2003 and 2005 and collected by Dr. E. A. Yağmur from the same

Samples were collected during field studies conducted during the day and night between March and October. During the field studies carried out

during the daytime, the samples were generally found under the stones in March-May; in the night field studies, samples were searched with a UV lamp in the May-October periods, when the weather was completely dark.

Phillips TL-D18W/BLB UV installed in direct current luminaires lamp assembly is installed. Under UV light, scorpions give off a phosphorescent light. The setup was operated with 12 Volt, 5 Amh dry batteries; discharged batteries were filled with an Ataba brand charger. The animals were seen either at the entrance of their nests or in the rock cracks while they were wandering around hunting. The samples were collected with long collets and fixed in 70% ethyl alcohol.

The identifications of the species were made based on Birula (1917a, 1917b) [25]-[26], Kinzelbach (1975) [27], Fet et al. (2009) [9], Kovarik et al. (2010) [10], Kovarik (2019) [8], Soleglad et al. (2012) [11], Tropea et al. (2012) [12], Yağmur et al. (2013a) [13], Yağmur et al. (2013b) [14], Tropea et al. (2014) [15], Yağmur and Tropea (2015) [16], Yağmur et al. (2015a) [17], Yağmur et al. (2015b) [18], Tropea and Yağmur (2016a) [19], Tropea et al. (2016a) [21], Tropea et al. (2016b) [22], Parmakelis et al. (2022) [2]. For each examined species, the ventral and dorsal appearances of male and female individuals are given. The number of samples examined and their locality information were processed. The bioecological characteristics of the species and its geographical distribution in Turkey are given.

Carina, extremity, and trichobothrial terminology were based on Francke (1977) [28], Hjelle (1990) [29], and Vachon (1974) [30].

A Benq DCC1035 brand camera was used to capture the habitats of the collected specimens and their photographs. The samples were diagnosed with a Nikon SMZ800 brand stereo microscope, and their photographs were taken using a Stemi 2000-C brand Stereo Microscope, a Powershot G 10, and a Samsung ES 73 camera attached to this microscope. Garmin Etrex Vista branded GPS and Google Earth programs were used for locality determination.

The collected samples were stored in 15 ml, 50 ml plastic tubes and in 100 ml and 200 ml glass jars. The samples are preserved in the author's personal collection.

The samples used for this article were collected from 6 provinces in Southwest Anatolia between May 2006 and September 2011. It is also adapted from the author's thesis project.

3. Results and Discussion

Identification key for scorpions detected in Southwest Anatolia Region

1. Lateral eyes 5 pairs, sternum triangular, pedipalp tibia ventrally without trichobotria, metasoma thicker than chela, chela round in cross-section.....Buthidae, *Aegaeobuthus gibbosus*

— Sternum pentagonal, 2-3 pairs, chela flat in cross section.....(2)

2. Lateral eyes 2-3 pairs, pedipalp tibia with 1 trichobotria ventrally, longer than the width of the chela, strong carina on the metasomaJuridae (3)

— Lateral eyes 2 pairs, pedipalp tibia with 6-10 trichobotria ventrally; chela broad and flat, metasoma with very weak keel or without keel.. Euscorpiidae (6)

3. 3rd and 4th legs have tibial spurs, lateral eyes are two pairs Calchinae, *Neocalchas gruberi*

— 3rd and 4th legs lack tibial spurs, lateral eyes are three pairs Iurinae (4)

4. There are 1 or 2 trichobotria (ea) on the outside of the pedipalp patella, the space in the male chela is very narrow, the count of comb teeth is 9-11 in females and 10-11 in males*Jurus kinzelbachi*

— There are no ea trichobotries (ea) on the outside of the pedipalp patella, the space in the male chela is quite wide, the number of comb teeth is 11-14 in males and 10-12 in females..... (5)

5. The chela fingers are long, there are two arches on the mobile finger and these arches are quite prominent, the chela is elongated and narrow *Metaiurus kadleci*

— The chela fingers are short, there is only one arch in the mobile finger and this arch is not prominent, the chela is quite swollen..... *Anatoliurus kraepelini*

6. The trichobotria number on the external side of the pedipalp patella in the em series is 3 7

— The trichobotria number on the external side of the pedipalp patella in the em series is 4 9

7. The trichobotria number on the ventral side of the pedipalp patella pv series 5-7 and external series et 4-6 *Euscorpium arikani*
- The trichobotria number on the ventral side of the pedipalp patella pv series 5-6 or 6-7 and external series et 3-4 or 5-68
8. The trichobotria number on the ventral side of the pedipalp patella pv series 5-6 and external series et 3-4 *Euscorpium sultanensis*
- The trichobotria number on the ventral side of the pedipalp patella pv series 6-7 and external series et 5-6 *Euscorpium honazicus*
9. The trichobotria number on the ventral side of the pedipalp patella pv series 6-8 *Euscorpium avcii*
- The trichobotria number on the ventral side of the pedipalp patella pv series 8-13 10
10. The trichobotria number on the external series of the pedipalp patella et is 7-8..... *Euscorpium gocmeni*
- The trichobotria number on the external series of the pedipalp patella et is 5-7.....*Euscorpium lycius*

Muğla province, Fethiye, Yeşil Üzümlü Village, 1 (1♂, 16 May 2008); Antalya province, Alanya, Taşatan Plateau, 2 (2♂♂, 09 June 2009); Aydın province, Dilek Peninsula National Park, 1 km inside the canyon, 5 (5♂♂, 07 June 2009); Aydın province, Aytepe 1 (1♂, 01 September 2004); Isparta province, Aksu, Çayır yayla road, Anamas Mountain, 37° 48' 58" N, 31° 07' 24" E, 1315 m. 1 (1♂, 09 August 2010); Muğla province, Köyceğiz, 36° 55' 53.2" N, 28° 42' 28.1" E., 1 (1♀, 27 February 2010); Aydın province, Çine, Near Topçam Dam Lake, 37° 41' 11" N, 28° 00' 42" E, 108 m., 1 (1♀, 23 October 2009); Muğla province, Fethiye, Akdağlar 3rd Station 36° 45' 08.6" N, 29° 38.3' 08" E, 1628 m., 1 (1♀, 01 August 2008); Denizli province, Babadağ, 37° 47' 16" N, 28° 52' 09" E, 1720 m., 5 (1♂, 4♀♀, 02 August 2008); Muğla province, Fethiye, Çiçek Babadağ, 1 (1♀, 02 August 2008); Antalya province, 31 km ahead of Zeytintasi Cave, 1 (1♀, 13 May 2010); Antalya province, Korkuteli Road 35. km, 2 (2♂♂, 16 May 2010); Antalya province, Korkuteli-Elmalı road 10. km, 1 (1♂, 16 May 2010); Denizli province, Honaz, 37° 49' 20" N, 29° 16' 37" E, 435 m., 2 (2♂♂, 17 October 2009); Antalya province, Korkuteli-Elmalı road 10. km., 1 (1♀, 16 May 2010); Antalya province, Serik, Akbaş Village, Altıntaş Cave, 1 (1♂, 15 July 2005); Antalya province, Korkuteli road 35. km, 2 (2♀, 16 May 2010); Muğla province, Fethiye, Çiçek Babadağ, 1 (1♀, 02 August 2008); Aydın province, Around Paşayayla Hotel, 37° 56.9' 08.2" N, 27° 53.4' 08.1" E., 2 (2♂, 30 July 2008); Antalya province, Serik, Akbaş Village, Altıntaş Cave, 1 (1♀, 15 July 2005); Muğla province, Datça, Palamut Bükü, 1 (1♂, 15 July 2010); Aydın province, Didim, near Dilek Peninsula National Park, 2 (2♀♀, 12 July 2010); Denizli province, Cankurtaran, 5 (2♂♂, 3♀♀, 23 June 2010); Antalya province, Korkuteli road 35. km, 2 (2♀, 16 May 2010); Antalya province, Korkuteli, Datköy, 1 (1♀, 14 July 2005); Muğla province, Eski Datça Mevkii, 3 (2♂♂, 1♀, 12 August 2004); Muğla province, Fethiye, Üzümlü Village, 6 (6♂♂, 02 May 2006); Muğla province, Lake Bafa, 37° 29' 29.4" N, 27° 32' 21.8" E. 14 m., 1 (1♂, 24 October 2009); Muğla province, Fethiye, Yanıklar, 36° 41' 53" N, 29° 02' 54.7" E., 9 m., 1 (1♀, 15 September 2009); Antalya province, Manavgat, Oymapınar Village, Poyrazlı Mevkii, 16 (9♂♂, 7♀♀, 05 August 2005); Antalya province, Tilkiler Mevkii, 11 (5♀♀, 6♂♂, 02 August 2005); Aydın province, Dilek Peninsula National Park, 37° 41' 41" N, 27° 13' 55" E., 3 (2♂, 1♀, 07 May 2011); Aydın province, Dilek Peninsula National Park, 5 (4♂♂, 1♀, 13 July 2010); Aydın province, Dilek Peninsula National Park, 1 (1♂, 07 May 2011); Muğla province, Datça, Palamut Bükü, 2 (2♀, 15 July

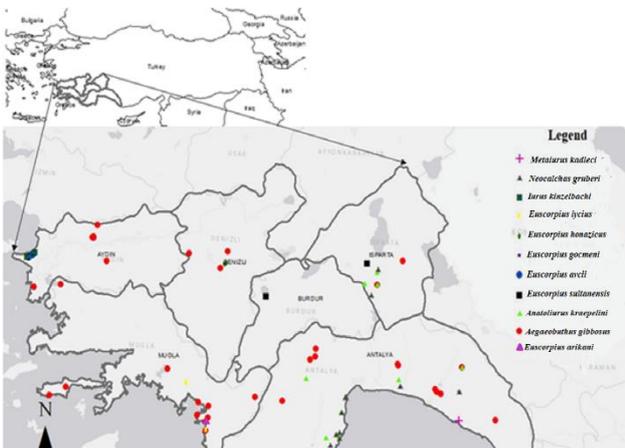


Figure 3. 1. Distribution Map of Detected Species

Family: Buthidae C.L. Koch, 1837 [31]

Genus: *Aegaobuthus* Kovarik, 2019 [8]

***Aegaobuthus gibbosus* (Brulle, 1832) [6]**

Material Examined: Aydın province, Kepez Location, 1 (1♂, 25 May 2004); Aydın province, Adnan Menderes University. campus, 1 (1♀, 31 July 2003); Aydın province, Söke, Dilek Peninsula National Park, 3 (1♂, 2♀, 17 April 2003); Antalya province, Manavgat, Oymapınar Canyon, 1 (1♀, 01 July 2004); Aydın: Center, 1 (1♂, July 23, 2003);

2010); Isparta province, 5 km south of Kovada Lake junction, 37° 38' 01" N, 30° 51' 41" E, 405 m., 1 (1♂, 11 May 2011); Muğla province, Fethiye, Faralya Village, 36° 29' 37" N, 29° 08' 07" E, 349 m., 1 (1♀, 30 May 2011); Aydın province, Kuşadası, Davutlar, Güzel Çamlı Village, 37° 41' 22" N, 27° 13' 31" E, 311 m., 14 (11♂♂, 3♀, 07 June 2011); Antalya province, 28 km north of Elmalı, 2 (1♂, 1♀, 08 July 2011); Antalya province, 12 km south of Akseki, 3 (1♂, 2♀♀, 09 July 2011).

Bioecological Notes: It is a species that prefers arid and warm environments. It has been determined that it spreads from sea level to 1800 m Yağmur 2005 [32]. In field studies, this species has been caught under stones in steppe habitats, in maquis, in pine forests, and along streams. Remains of insects that these scorpions were fed were also found under the stones where they were caught.

As a result of feeding a pregnant specimen caught in the field under laboratory conditions, it was determined that she gave birth to 42 puppies, but since the moment of birth could not be observed, it is possible that this number is higher. It has been observed that this species ate grasshoppers, spiders, flies, mantises, butterflies, and lizards while feeding in laboratory conditions. It has been determined that scorpions feed by using their pedipalps, just like humans use their hands and arms, after first poisoning and neutralizing their prey by stinging them with their sting. It has been observed that scorpions do not move much during the daytime, so it is thought that they aim to use their energy efficiently.

Distribution in Turkey: Mediterranean Region, Egean Region, Central Anatolia Region, south of the Black Sea Region.



Figure 3.2. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Aegaeobuthus gibbosus*

Family: Euscorpiidae Laurie, 1896 [33]

Genus: *Euscorpius* Thorell, 1876 [34]

Euscorpius arikani, Yagmur & Tropea, 2015 [16]

Material Examined: E. Arikani Muğla: Köyceğiz, Çiçek Babadağ, 3 (2♂, 1♀, 02 August 2008).

Bioecological Notes: *Euscorpius arikani* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and cavities in the soil in rocky areas. It has been observed

that they are generally active during the cooler times of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons, and high mountains.

Distribution in Turkey: Antalya, Muğla. This species was recorded from Muğla province for the first time.

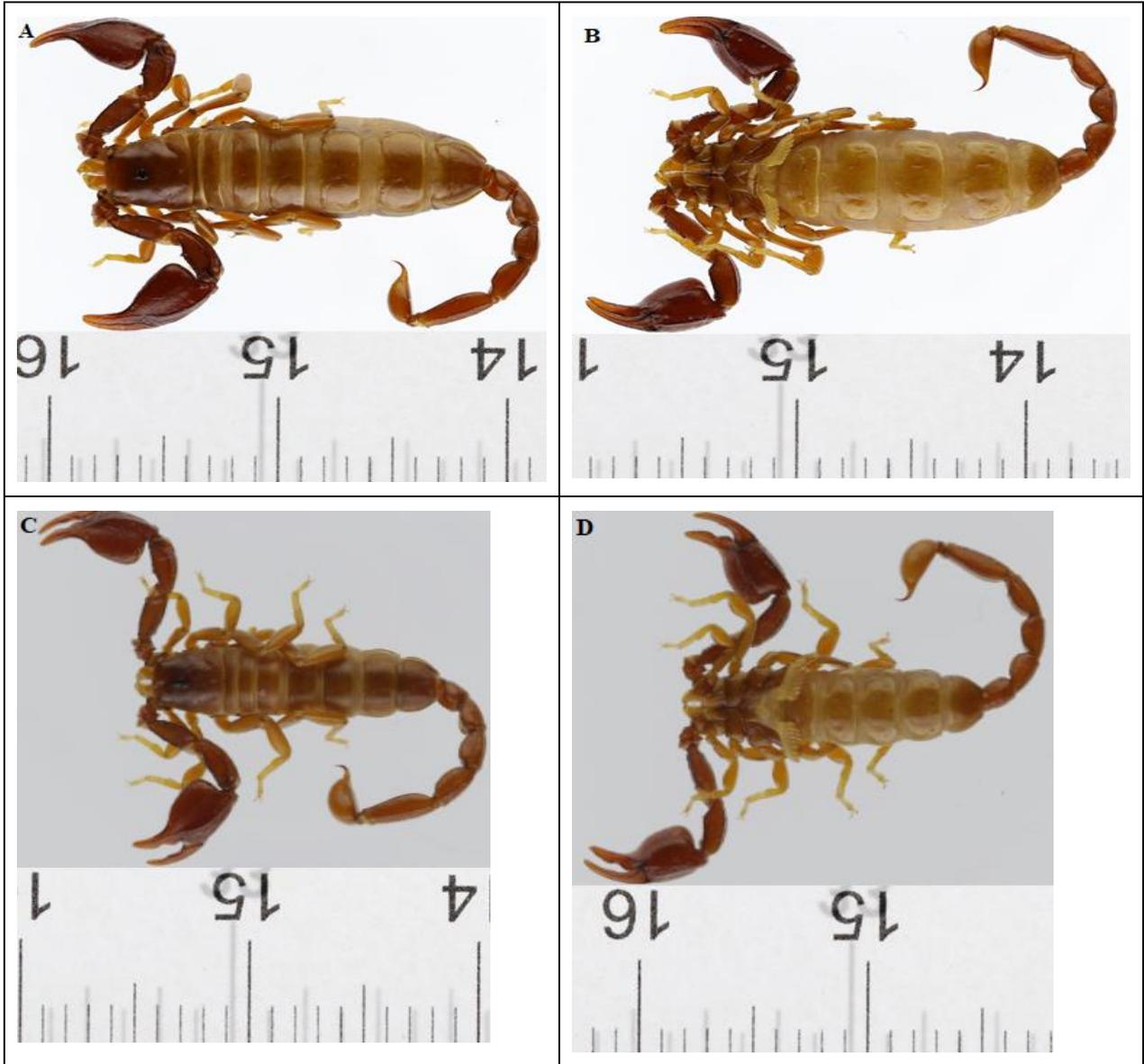


Figure 3.3. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpium arikani*

Euscorpium avcii, Tropea, Yağmur, Koç, Yeşilyurt & Rossi, 2012 [12]

Material Examined: Aydın: Dilek Peninsula National Park, 22 (7♂♂, 15♀♀, 13 July 2010); Aydın: Dilek Peninsula National Park, 4 (2♂♂, 2♀♀, 07 May 2011); Aydın: Kuşadası, Davutlar, Güzel Çamlı N., 37° 41' 22" N, 27° 13' 31" E, 311 m. 15 (4♂♂, 11♀♀, 07 June 2011)

Bioecological Notes: *Euscorpium avcii* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and cavities in the soil in rocky areas. It has been observed that they are

generally active during the cooler times of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons, and high mountains.

Distribution in Turkey: Aydın.

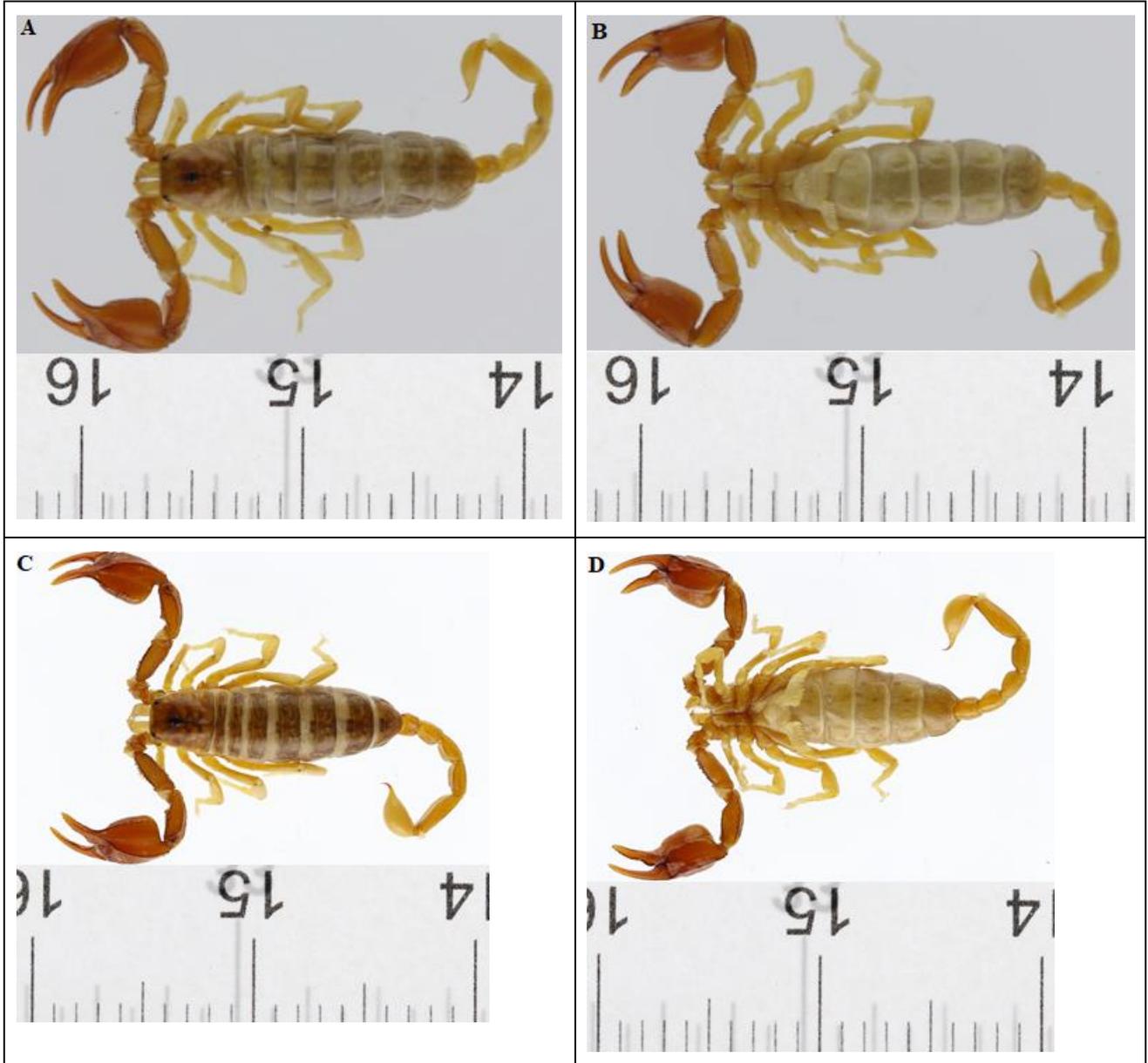


Figure 3.4. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpium avcii*

Euscorpium gocmeni, Tropea, Yağmur and Yeşilyurt, 2014 [15]

Material Examined: Antalya: Akseki, Murtiçi, 36° 51' 54" N, 31° 45' 04" E. 493 m. 8 (6♂♂, 2♀♀, 01 September 2011).

Bioecological Notes: *Euscorpium gocmeni* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and cavities in the soil in rocky areas. It has been observed that they are generally active during the cooler times

of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons and high mountains.

Distribution in Turkey: Antalya.



Figure 3.5. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpium gocmeni*

E. honazicus, Tropea, Yağmur, Karampatsou, Parmakelis & Yeşilyurt, 2016a [21]

Material Examined: Denizli: Honaz Mountain, 37° 44' 16" N, 29° 15' 47" E, 871 m. 17 (5♂♂, 12♀♀, 17 October 2009); Denizli: Honaz Mountain Second Station, 37° 43' 50" N, 29° 14' 52" E, 1161 m. 3 (3♂♂, October 17, 2009); Burdur: Salda Lake Side, Yeşilova 5. km, 37° 30' 32.2" N, 29° 41' 58.4" E, 1168 m. 8 (7♂♂, 1♀, 16 October 2009)

Bioecological Notes: *Euscorpium honazicus* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and

cavities in the soil in rocky areas. It has been observed that they are generally active during the cooler times of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons and high mountains.

Distribution in Turkey: Denizli and Burdur. This species was recorded from Burdur province for the first time.



Figure 3.6. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpium honazicus*

Euscorpium lycius, Yağmur, Tropea and Yeşilyurt, 2013a [13]

Material Examined: Muğla: Fethiye, Faralya N., 36° 29' 37" N, 29° 08' 07" E, 349 m. 12 (5♂♂, 7♀♀, May 30, 2011)

Bioecological Notes: *Euscorpium lycius* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and cavities in the soil in

rocky areas. It has been observed that they are generally active during the cooler times of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons and high mountains.

Distribution in Turkey: Antalya and Muğla.

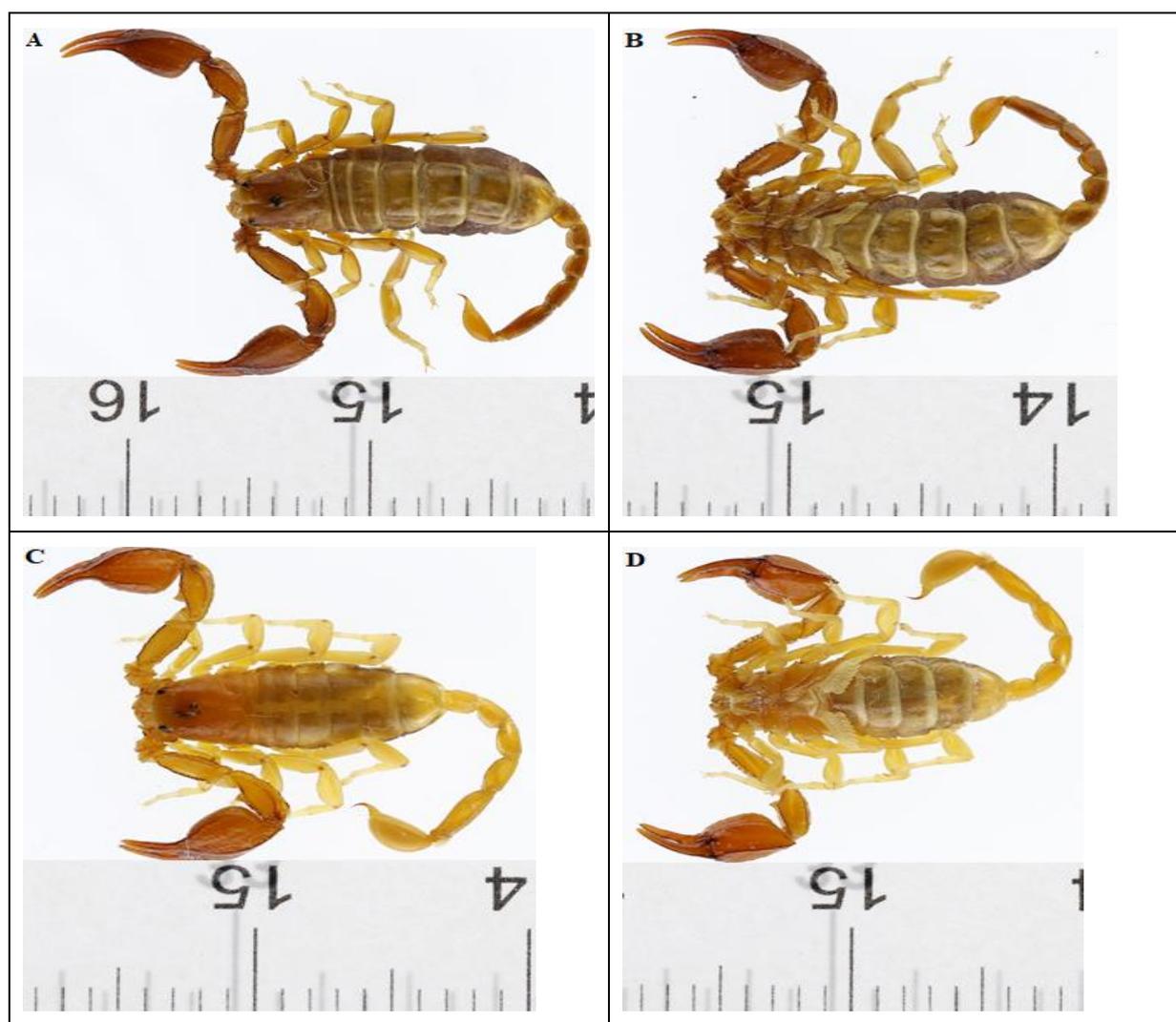


Figure 3.7. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpium lycius*

Euscorpium sultanensis, Tropea and Yağmur, 2016a [19]

Material Examined: Isparta: Davraz Mountain, 37° 47' 14" N, 30° 44' 52" E, 44% humidity, 1838 m. 8 (6♂♂, 2♀♀, 09 August 2009)

Bioecological Notes: *Euscorpium sultanensis* was collected from under stones in the pine forest. In addition, it has been detected in the field studies carried out at night while waiting in rock cracks and cavities in the soil in rocky areas. It has been observed

that they are generally active during the cooler times of the year. In addition, their habitats are in regions that are constantly humid throughout the year. For this reason, they have been detected locally only in regions such as valleys, canyons and high mountains.

Distribution in Turkey: Sultan Mountains and Davraz Mountain, Isparta. This species was recorded from Isparta province for the first time.

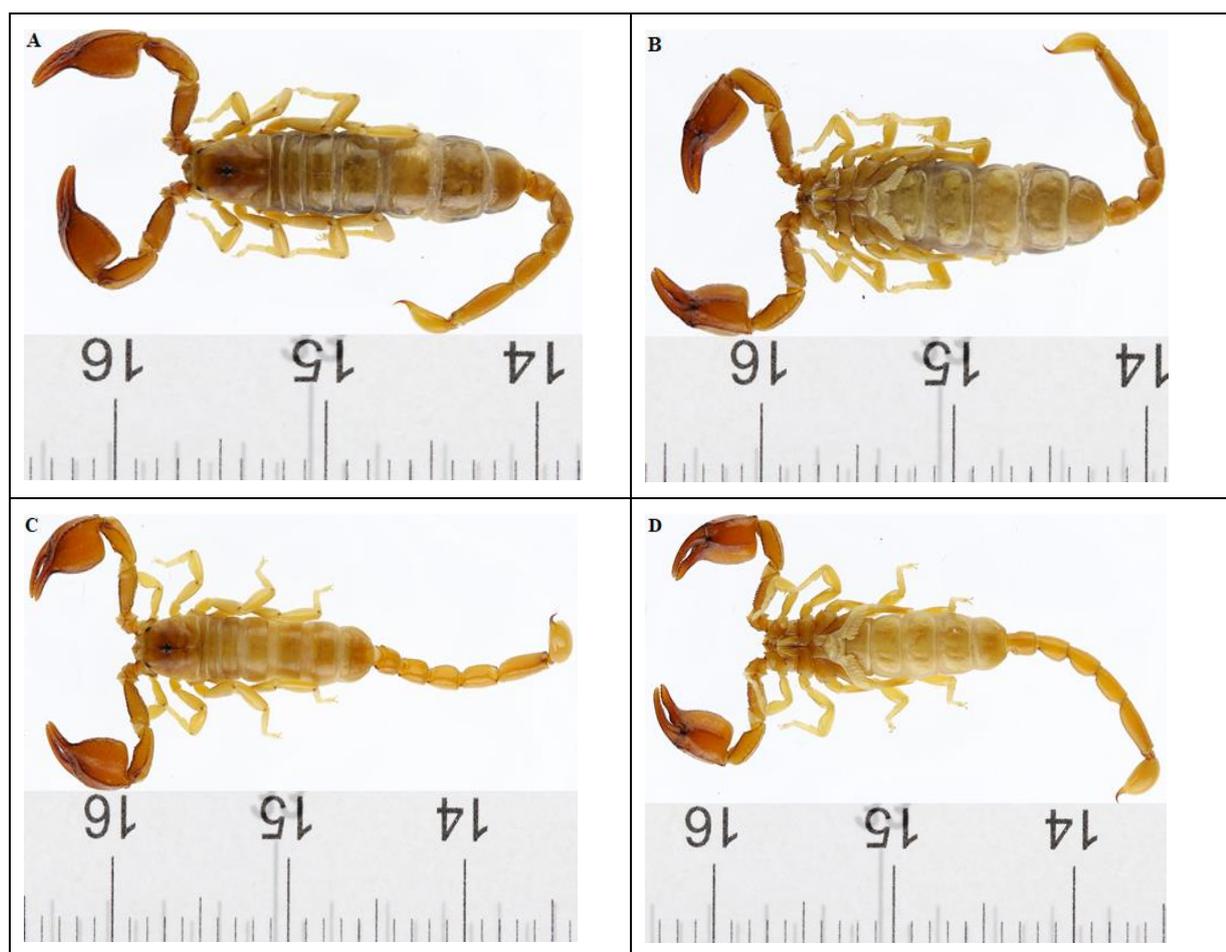


Figure 3.8. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Euscorpis sultanensis*

Familiya: Iuridae Thorell, 1876 [34]

Genus: *Neocalchas* Yağmur et al. 2013b [14]

Neocalchas gruberi Fet, Soleglad et Kovařík, 2009 [9]

Material Examined: Antalya province, Kemer district, Botanik Restaurant, Tekirova, 1 (1♂, September 12, 2010); Isparta province, Eğirdir, Kırıntı, 1 (1♀, 14 May 2010); Antalya province, Kemer, Küçük Çaltıcak Beldibi, 36° 47' 42.8" N, 30° 34' 21.6" E, 62% humidity 7 m. 1 (1♀, 14 March 2009), Antalya province, Kesboğazi National Park, Forest Area 1 (1♀, 12 May 2010); Antalya province, Tekirova, Woodland 2 (1♀, 1♂, 12 May 2010); Isparta province, Eğirdir, Kırıntı, route to Antalya road 1 (1♂, 14 May 2010); Antalya province, 1.5 km west of Camyuva Town, 36° 31' 54.8" N, 30° 31' 14.4" E., 3 (3♂♂, 15 March 2009); Antalya province, Kemer, Küçük Çaltıcak, Beldibi, 36° 47' 42.8" N, 30°

34' 21.6" E, 62% humidity 7 m. 2 (2♀♀, March 14, 2009); Antalya province, Küçük Çaltıcak Center, 36° 47' 42.4" N, 30° 34' 21.3" E. 18 m. 2 (1♂, 1♀, April 30, 2011); Antalya province, Kemer, Olympos road junction 0.5 km 36° 26' 07.4" N, 30° 25' 42.3" E. 382 m. 1 (1♂, April 03, 2011); Antalya province, Küçük Çaltıcak, 4 (4♂♂, 02 May 2006); Antalya province, Kemer, Goynuk Canyon, 1 (1♂, 04 August 2011); Antalya province, Akseki, Murtiçi, 36° 51' 54" N, 31° 45' 04" E. 493 m. 5 (3♂♂, 2♀♀, 01 September 2011).

Bioecological Notes: *Neocalchas gruberi* was gathered from under rock and stones in pine forests and in bushes. It was also detected in the field studies carried out at night on limestone cliffs. It has been observed that they are generally active during the cooler times of the year. For this reason, it can be found mostly between March and June when the season is humid and the air temperature is low.

Distribution in Turkey: Antalya, Mersin and Isparta province. *Neocalchas gruberi* is recorded for the first time from Isparta.



Figure 3.9. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Neocalchas gruberi*

Familya: Iuridae Thorell, 1876 [34]

Genus: *Metaiurus* Parmakelis, Dimitriadou, Gkigkiza, Karampatsou, Stathi, Fet, Yagmur & Kovarik, 2022 [2]

Metaiurus kadleci Kovarik, Fet, Soleglad et Yağmur, 2010 [10]

Material Examined: Antalya province, Alanya district, İncekum town, nameless little cave, 1 (1♀, 20 March 2009).

Bioecological Notes: The only specimen in this study was found inside the cave. Kovarik et al. (2010) reported this species from scrub areas near the pine forest. They also reported an example from inside the cave. Probably this species, like *Neocalchas gruberi*, prefers cool times and tends to hide in caves.

Distribution in Turkey: Antalya & Mersin.

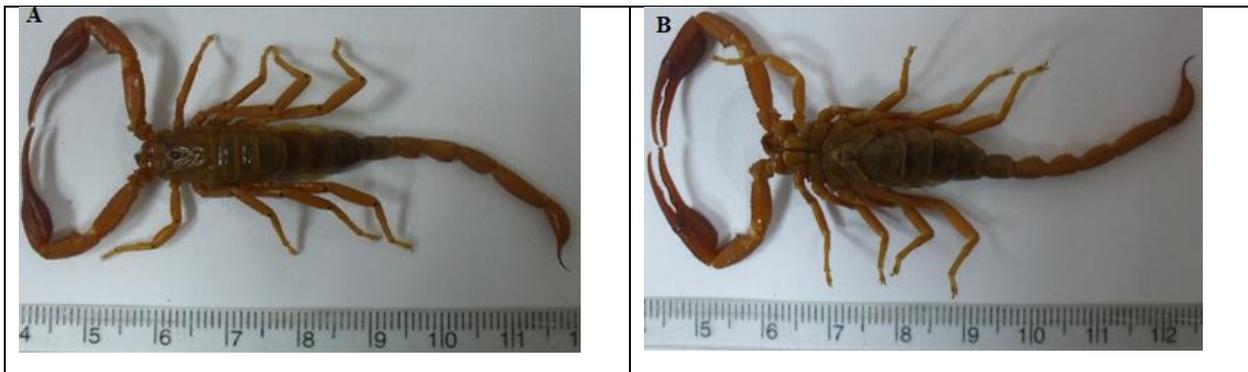


Figure 3.10. A. Dorsal View B. Ventral View in Female *Metaiurus kadleci*

Familya: Iuridae Thorell, 1876 [34]

Genus: *Iurus* Thorell, 1876 [34]

Iurus kinzelbachi Kovařík, Fet, Soleglad et Yağmur, 2010 [10]

Material examined: Aydın province, Dilek Peninsula National Park, 4 (2♂♂, 2♀♀, 13 July 2010); Aydın province, Kuşadası, Davutlar, 25 (17♀♀, 8♂♂, 1 June 2011).

Bioecological Notes: *Iurus kinzelbachi* specimens were collected from pine forest edges and limestone cliffs during nighttime fieldwork. As with other *Iurus* species, it has been observed that this species prefers warm seasons. In the field studies, it has been observed that this species tends to hide in crevices under large stones and in rock cracks.

Distribution in Turkey: Aydın.



Figure 3.11. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Iurus kinzelbachi*

Familiya: Iuridae Thorell, 1876 [34]

Genus: *Anatoliurus* Parmakelis, Dimitriadou, Gkigkiza, Karamatsou, Stathi, Fet, Yagmur & Kovarik, 2022 [2]

Anatoliurus kraepelini von Ubisch, 1922 [4]

Material Examined: Antalya province, Kemer road, under the Botanic Restaurant, 3 (1♂, 2♀♀, 21 May 2006); Antalya province, Korkuteli road 35. km, 3 (3♀♀, 16 May 2010); Antalya province, Kemer, Botanic Restaurant, 1 (1♀, 12 May 2010); Antalya province, 3 km ahead of Serik, 1 (1♂, 12 May 2010); Antalya province, Kemer, Beldibi, 36° 47' 42.8" N, 30° 34' 21.6" E, 7 m Humidity 62.2 % 2 (2♀♀, 14 March 2009); Isparta province, Egirdir, Kırıntı Village, 1 (1♂, 14 May 2010); Isparta province, 5 km ahead of Isparta-Antalya Road Kazak 1 Tunnel, 1 (1♀, 14 May 2010); Muğla province, between Fethiye-Göcek 1 picnic area with daily diary, 35° 40' 65" N, 68° 05' 13" E., 1 (1♂, 10 April 2011); Antalya province, Kemer-Kumluca Road, 4 km inside the Tahtalı Mountain junction, 1 (1♂, 24 April 2011); Antalya province, Küçük Çaltıcak Center, 36° 47' 42.4" N, 30° 34' 21.3" E, 18 m., 1 (1♂, 30 April 2011); Antalya province, Kemer, Olympos Road junction 0.5 km, 36° 26' 07.4" N, 30° 25' 42.3" E, 382 m., 1 (1♂,

03 April 2011); Isparta province, 5 km south of Kovada Lake junction, 37° 38' 01" N, 30° 51' 41" E, 405 m. 18 (10♂♂, 8♀♀, 11 May 2011); Muğla province, Fethiye, Faralya N., 36° 29' 37" N, 29° 08' 07" E, 349 m., 2 (1♂, 1♀, 30 May 2011); Antalya province, Kemer, Lycian way, Göynük Canyon, 36° 41' 18" N, 30° 31' 33" E, 121 m., 22 (10♂, 12♀♀, 04 July 2011); Denizli province, Serinhisar, 3 km south of Altınyayla, 1 (1♀, 08 July 2011); Antalya province, Elmalı, 2 km south of Gömücü Village, 36° 24' 22" N, 29° 42' 02" E, 970 m., 2 (2♀♀, 09 July 2011); Antalya province, Akseki, 12 km south, 5 (5♀♀, 09 July 2011).

Bioecological Notes: *Anatoliurus kraepelini* was gathered from under rocks in pine forests and in bushes. It was also detected in the field studies carried out at night on limestone cliffs. It has been observed that they tend to hide in rock cracks and sometimes in some cavities in the soil during field studies carried out at night. They have been found to be intensely active during the warmer times of the year.

Distribution in Turkey: Antalya, Isparta, Konya, Mersin, Muğla, Denizli. This species is determined for the first time from Isparta and Denizli provinces.



Figure 3.12. A. Dorsal, B. Ventral View in Female, C. Dorsal, D. Ventral View in Male *Anatoliurus kraepelini*

4. Conclusion and Suggestions

In this article, specimens collected from 6 provinces in the Southwest of Turkey were examined, and 11 species were identified in 6 genera belonging to 3 families: *Aegeabuthus gibbosus*, *Anatoliurus kraepelini*, *Euscorpius arikani*, *E. avcii*, *E. gocmeni*, *E. honazicus*, *E. lycius*, *E. sultanensis*, *Iurus kinzelbachi*, *Metaiurus kadleci*, and *Neocalchas gruberi* are spread in the research area of Turkey.

Neocalchas gruberi was determined from Isparta province, *Euscorpius arikani* was recorded from Muğla province, *E. honazicus* species was determined from Burdur province, *E. sultanensis* species was determined from Isparta province, *Anatoliurus kraepelini* was determined from Isparta and Denizli provinces, for the first time.

Scorpions have a total of 2748 species, according to current data worldwide [35]. According to recent contributions, there are 46 scorpion species in Turkey and 14 in the research area. The research area covers approximately 30 percent of the number of scorpion species in Turkey.

The research area is rich in scorpion species diversity. It has been an important thesis study in terms of shedding light on future studies. This study

will make valuable contributions to the scorpion systematics in Turkey after more detailed analyses with studies in other regions.

Acknowledgment

This publication is produced from the author's thesis study. I would like to thank Kırıkkale University Scientific Research Unit for supporting the author's thesis study with the research project numbered 2009-36.

I would like to thank Dr. Erkan Azizoğlu for his contributions in the preparation of the map.

Contributions of the authors

All work was done by the corresponding author. Since the second author is the thesis advisor of the corresponding author, it is included in the article in terms of ethics.

Conflict of Interest Statement

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

The study is complied with research and publication ethics

References

- [1] H. Arıkan, E. Akçiçek. Akrepler “Yaşayan Fosiller”, İzmir: Ege Üniversitesi Yayınları, İzmir No: 222, ss. 9-34, 2022.
- [2] A. Parmakelis, D. Dimitriadou, E. Gkigkiza, L. Karampatsou, I. Stathi, V. Fet, E., A. Yagmur, F. Kovařík. “The evolutionary history of the relict scorpion family Iuridae of the eastern Mediterranean”. *Molecular Phylogenetics and Evolution*, 177: 1-15, 2022.
- [3] F. Kovařík, V. Fet, B. Gantenbein, M. R. Graham, E. A. Yağmur, F. Šťáhlavský, N. M. Poverennyi & N. E. Novruzov. “A revision of the genus *Mesobuthus* Vachon, 1950, with a description of 14 new species (Scorpiones: Buthidae)”. *Euscorpius*, vol.2022, no.348, pp. 1–189, 2022.
- [4] M. von Ubisch, “Über eine neue Jurus-Art aus Kleinasien nebst einigen Bemerkungen über die Funktion der Kämmen der Skorpione,” *Zool. Jahrb., Abt. Syst.*, vol. 44, no. 1-2, pp. 503-515, 1922.
- [5] E. Schenkel, “Einige Mitteilungen über Spinnentiere,” *Rev. Suisse Zool.*, vol. 54, no.1, pp. 13-16, 1947.
- [6] A. Brullé. “Des Animaux articulés. Scorpionides. In: Baron J. B. G. M. Bory de Saint Vincent (ed.), Expédition scientifique de Morée,” *Section des sciences physiques. Zoologie. Paris*, vol.3 no. 1, pp. 57-60, 1832.
- [7] M. Vachon. “Etudes sur les Scorpions. III (suite). Description des Scorpions du Nord de l’Afrique,” *Arch. Institut Pasteur d’Algérie*, vol. 28, no.2, pp. 152-216, 1950.
- [8] F. Kovařík, “Taxonomic reassessment of the genera *Lychas*, *Mesobuthus*, and *Olivierus*, with descriptions of four new genera (Scorpiones: Buthidae),” *Euscorpius*, vol. 288, pp. 1–27, 2019.
- [9] V. Fet, M. E. Soleglad and F. Kovařík, “Etudes on iurids, II. Revision of genus *Calchas* Birula, 1899, with the description of two new species (Scorpiones: Iuridae),” *Euscorpius*, vol. 82, pp. 1–72, 2009.
- [10] F. Kovařík, V. Fet, M. E. Soleglad and E. A. Yağmur, “Etudes on iurids, III. Revision of the genus *Iurus* Thorell, 1876 (Scorpiones: Iuridae), with a description of two new species from Turkey”, *Euscorpius*, vol. 95, pp. 1–212, 2010.
- [11] M. E. Soleglad, V. Fet, F. Kovařík. and E. A. Yağmur, “Etudes on iurids, V. Further revision of *Iurus* Thorell, 1876 (Scorpiones: Iuridae), with a description of a new genus and two new species,” *Euscorpius*, vol. 143, pp. 1–70, 2012.
- [12] G. Tropea, E. A. Yağmur, H. Koç, F. Yeşilyurt & A. Rossi. “A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from Turkey,” *ZooKeys*. Vol. 219, pp. 63-80, 2012.
- [13] E. A. Yağmur, G. Tropea & F. Yeşilyurt. “A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from south western Turkey,” *ZooKeys*, vol. 348, pp. 29–45, 2013a.
- [14] E. A. Yağmur, M. E. Soleglad, V. Fet & F. Kovařík. “Etudes on iurids, VI. Further revision of *Calchas* Birula, 1899 (Scorpiones: Iuridae), with a description of a new genus and two new species,”. *Euscorpius*, vol. 159, pp. 1–37, 2013b.
- [15] G. Tropea, E. A. Yağmur & F. Yeşilyurt. “A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from the Antalya Province, Southern Turkey,” *Euscorpius*, vol.184, pp. 1–13, 2014.
- [16] E. A. Yağmur & G. Tropea. “A new species of *Euscorpius* Thorell, 1876 from southwestern Turkey (Scorpiones: Euscorpius).” *Arachnida*, vol. 3, pp. 14–26, 2015.
- [17] E. A. Yağmur, M. E. Soleglad, V. Fet & F. Kovařík. “Etudes on iurids, VIII. A new *Protoiurus* species from the Hidirellez Cave in Antalya, Turkey (Scorpiones: Iuridae),” *Euscorpius*, vol.200, pp. 1–25, 2015a.
- [18] E. A. Yağmur, F. Kovařík, V. Fet, M. E. Soleglad & F. Yeşilyurt. “Etudes on iurids, IX. Further analysis of a rare species *Protoiurus kadleci* (Scorpiones: Iuridae) from Turkey, based on adult males,” *Euscorpius*, vol. 201, pp. 1-18, 2015b.
- [19] G. Tropea & E. A. Yağmur. “A new species of *Euscorpius* Thorell, 1876 from the Sultan Mountains in western Turkey (Scorpiones: Euscorpiidae),” *Arachnida*, vol. 6, pp. 32–43, 2016a.
- [20] G. Tropea & E. A. Yağmur. “Two New Species of *Euscorpius* Thorell, 1876 from Southern Turkey (Scorpiones: Euscorpiidae),” *Euscorpius*, vol. 234, pp. 1-19, 2016b.
- [21] G. Tropea, E. A. Yağmur, L. Karampatsou, A. Parmakelis & F. Yeşilyurt. “A new species of *Euscorpius* Thorell, 1876 from Mount Honaz in southwestern Turkey (Scorpiones: Euscorpiidae),” *Euscorpius*, vol. 222, pp. 1–14, 2016a.

- [22] G. Tropea, E. A. Yağmur, A. Parmakelis & K. B. Kunt. “Another new species of *Euscorpius* Thorell, 1876 from the Taurus Mountains in Antalya Province, Southern Turkey (Scorpiones: Euscorpiidae),” *Euscorpius*, vol. 231, pp. 1–15, 2016b.
- [23] E. A. Yağmur. “On R. Kinzelbach’s euscorpiid specimens from Turkey deposited in the Naturhistorisches Museum Mainz, Germany (Scorpiones: Euscorpiidae),” *Euscorpius*, vol. 334, pp. 1-5, 2021a.
- [24] S. Cain, E. Gefen and L. Prendini. “Systematic Revision of the Sand Scorpions, Genus *Buthacus* Birula, 1908 (Buthidae C.L. Koch, 1837) of the Levant, with Redescription of *Buthacus arenicola* (Simon, 1885) from Algeria and Tunisia,” *Bulletin of the American Museum of Natural History*, vol. 450, p. 134, 2021.
- [25] A. A. Birula. Arthrogastric Arachnids of Caucasia, I: Scorpions, Ann. Caucasian Museum, Tiflis, A 5, 253 pp. [in Russian], English translated by J. Salkind, Edited by E. Rabinovitz, Israel Program for Scientific Translation, No. 1206, Jerusalem, 1964, v+170 pp, 1917a.
- [26] A. A. Birula. Fauna of Russia and Adjacent Countries: Arachnoidea, Vol. I, Scorpions, No. 1, in: Petrograd, xx+224 pp. [in Russian], English translated by B. Munitz, Edited by E. Rabinovitz, Israel Program for Scientific Translation, Jerusalem, 1965, xix+154 pp, 1917b.
- [27] R. Kinzelbach. “Die Skorpione der Ägäis: Beiträge zur Systematik, Phylogenie und Biogeographie, The Aegean Scorpions,” *Zool. Jb. Syst. Bd.*, vol.102, pp. 12-50, 1975.
- [28] O. F. Francke. “Scorpions of the genus *Diplocentrus* from Oaxaca, Mexico (Scorpionida, Diplocentridae),” *Journal of Arachnology*, vol. 4, pp. 145-200, 1977.
- [29] J. T. Hjelle. Anatomy and morphology. Pp. 9– 63 In: Polis G.A. (ed.). *The Biology of Scorpions*. Stanford, CA: Stanford University Press, 587 pp, 1990.
- [30] M. Vachon. “Etude des caractères utilisés pour classer les familles et les genres de scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les scorpions,” *Bulletin du Muséum National d’Histoire naturelle*, Paris. Vol. 140, pp. 859-958, 1974.
- [31] C. L. Koch. *Die Arachniden*. Nürnberg: C. H. Zeh’sche Buchhandlung, 4(1–5): 1–108, 1837.
- [32] E.A. Yağmur, *Scorpions of Gaziantep (Ordo: Scorpiones) and Their Zoogeographic Distributions*. Master Thesis, Gaziantep University, Gaziantep, 2005.
- [33] M. Laurie. Notes on the anatomy of some scorpions, and its bearing on the classification of the order. *Annals and Magazine of Natural History Ser.* Vol.6, no.17, pp. 185-194, 1896.
- [34] T. Thorell. “On the classification of scorpions,” *Annals and Magazine of Natural History*, vol. 4, no. 17, pp. 1–15, 1876.
- [35] J. O. Rein, “The Scorpion Files”, [www.ub.ntnu.no/scorpion-files/], Erişim tarihi: 28.12.2022.