The Second Record of a Relict *Akrav israchanani* Levy, 2007 (Scorpiones: Akravidae) from Levana Cave, Israel

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The second record of a relict *Akrav israchanani* Levy, 2007 (Scorpiones: Akravidae) from Levana Cave, Israel

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Summary

We report the remnants of five new scorpion specimens discovered dead in Levana Cave in Israel in December 2015. We confirm that they belong to the relict scorpion *Akrav israchanani* Levy, 2007 (Akravidae), famously described from the neighboring Ayyalon Cave, also from dead specimens. The details of morphology of the new specimens are given; they match completely the characters of *A. israchanani* redescribed by Fet, Soleglad & Zonstein (2011). This second record indicates a wider distribution of this unique cave scorpion, which, however, is extinct in both caves. There is still no evidence that live populations of this species exist.

Introduction

A relict, blind scorpion *Akrav israchanani* was described from Ayyalon Cave in central Israel by Gershom Levy (2007) and placed in a separate monotypic chaetoid family Akravidae Levy, 2007. All scorpions found in this cave (20 specimens) were dead, represented by exoskeletons but extremely well preserved, and fluorescent under UV light. Time and cause of death are unknown; there is no evidence of fossilization.

Fet, Soleglad & Zonstein (2011) revised Levy’s specimens describing and illustrating many morphological characters in detail. In particular, the monotypy of Akravidae was challenged and affinities to the New World family Typhlochactidae was demonstrated. A combination of scorpion’s ecological adaptations and trophic chains of the Ayyalon Cave implied that this scorpion might have survived on aquatic (crustacean) prey. All of specimens were originally collected as dried, dead skins (not exuvia); no live scorpions have been found. For much more detail, see Fet, Soleglad & Zonstein (2011).

In December 2015, five new dead specimens were discovered in a separate cave, located very close (350 m) to the Ayyalon Cave. We studied these remnants and conclude that they belong to the same species. This second record shows that the population of *Akrav israchanani* was not limited to Ayyalon Cave. There is still no evidence that live scorpions of this species exist.

The Levana Cave and its Scorpions

Levana Cave is located 350 m ENE of Ayyalon Cave, sharing a similar setting: Turonian B’ina Formation, within the Ayyalon salinity anomaly of Yarkon-Taninim aquifer, at the watertable and above it. Levana Cave was breached by Nesher quarry in 2015 (Frumkin & Naaman, 2015).

Levana Cave is 493 m long (Fig. 1). Its major passage is 140 m long generally sloping to SW towards the watertable, meeting it at several points. Its common width is between 2–15 m, and height is commonly between 1–10 m. The present watertable of the Yarkon-Taninim aquifer appears at several points in the cave, and the water depths reaches 2 m (Fig. 2). The water is partly covered by a bacterial mat serving as the base of the chemosynthetic ecosystem (Por et al., 2016). In addition to the main passage, the NE part of the cave is a 3-dimensional maze of narrow passages and shafts. The
Figure 1: Levana Cave profile with location of scorpion specimens. Surveyed by Israel Cave Research Center, 2015.
presently accessible entrance is located at the upper part of this maze.

The dead scorpion specimens, fluorescent under UV light (Fig. 3), were found in partially articulated condition, on and between dry rocks of a talus slope, within the northern part of the major passage, 26–30 m above sea level (Figs. 1–2). This corresponds to a few meters above the pre-1960 watertable (~24 m asl), before modern pumping has lowered the water level in the aquifer and the cave (Frumkin & Gvirtzman, 2006). The

Figure 2: Levana Cave. Top, The scorpion chamber in Levana Cave. Scorpion specimens were found on and between boulders. Bottom, Watertable of Levana Cave in 2015, with bacterial mat serving as the base of the chemoautotrophic ecosystem. Photographs: Amos Frumkin.
Figure 3: *Akrav israchanani*. **Top**, Scorpion as found at Levana Cave. **Bottom**, Scorpion as found at Levana Cave, using UV light. Photographs: Boaz Langford.
scorpion specimens previously described from Ayyalon Cave were found at similar levels, corre-sponding to a similar historic watertable. The populations of this species in both caves became extinct probably due to the massive drop of water level in the cave and resulting reduction in primary production at the water surface.

The Nesher quarry is known to cut into several caves of the same type, as exemplified by Ayyalon and Levana caves. However, no physical connections via cave passages of human size were observed between Ayyalon and Levana Caves. The connection between Ayyalon and Levana Caves must have been via smaller passages, inaccessible to humans.

**Material & Methods**

Three vials deposited at the Hebrew University, Jerusalem, Israel, contain remnants of five scorpion specimens. One contains a single exoskeleton which is partially fragmented; two others contain completely fragmented specimens (most probably, judging from a number of the chelae, each with remnants of two specimens in each of them). Samples are not numbered. Label data (an “umbrella” label for all three samples) is: “Israel Levana Cave 12/17/15 [= 17 Dec. 2015] Coll. Israel Naaman & Shlomi Lubaton.” Photographs were taken by S.Z. at Tel-Aviv University using a Zeiss Discovery V20 stereo-microscope with a Canon PowerShot G9 camera, and prepared using the Helicon ver. 6.3.2Pro (licensed) soft-ware. Measurements (in mm) are given in Table 1.

**Character Analysis**

Here, we compare the morphology of the specimens recently found in the Levana Cave to the *Akrav israchanani* specimens from the Ayyalon Cave described in detail by Fet, Soleglad & Zonstein (2011). Based on several important diagnostic characters, it is shown here that the specimens from the Levana Cave are indeed the species *Akrav israchanani*.

Although we do not have complete specimens from the Levana Cave, more than enough structures are available, illustrated and described herein, to demonstrate that these specimens are *Akrav israchanani*.

**Overall Coloration.** In the Levana Cave specimens (Figs. 3–4) overall coloration is a light pale-gray, with reddish chelal fingers. In contrast, in the Ayyalon Cave specimens (Fet, Soleglad & Zonstein, 2011: fig. 4) overall coloration is a light yellowish-brown, with reddish chelal fingers.

**Carapace.** The carapace of the Levana Cave specimens (Fig. 5) is elongate with a width, deep anterior indentation. The carapace is missing both median and lateral eyes, i.e. scorpions are completely blind. Its surface is rough but essentially devoid of carinae. This description matches the specimens from the Ayyalon Cave described by Fet, Soleglad & Zonstein (2011: figs. 4–5).

**Chelicerae.** Structure of the chelicerae of *A. israchanani* described by Fet, Soleglad & Zonstein (2011: 36; figs. 5, 32) from the Ayyalon Cave is unique, and typical of many of the chelicerae found in subfamily Typhlochactinae: single subdistal (sd) denticle on the movable finger dorsal edge, distal denticles (dd) of the dorsal and ventral edges of the movable finger are unequal in size, the ventral much longer, and the median (m) and basal (b) denticles of the fixed finger do not form a bicuspid. In the Levana Cave specimens (Fig. 6) only the movable finger is partially visible. However, from this we can see that it has a single sd and the ventral dd is longer than the dorsal dd, matching the description of these denticles as presented above for the Ayyalon Cave specimens.

**Telson.** The telson of *A. israchanani* is quite distinct with is large bulbous vesicle and short, highly curved aculeus (Fet, Soleglad & Zonstein, 2011: fig. 10).
Figure 4: *Akrav israchanani*, Levana Cave, Israel. Ventral view showing sternocoxal area and sternites.
Figure 5: *Akrav israchanani*, Levana Cave, Israel. Carapace and chelicerae.

In the Levana Cave specimens (Fig. 7), the telson has the same shape.

**Leg Tarsus.** In Fet, Soleglad & Zonstein (2011: figs. 11, 30) the leg tarsus is shown. In particular we see three important diagnostic characters for *A. israchanani*: the retrolateral pedal spur is missing, only the prolateral spur is present; the median ventral aspect of the tarsus lacks a spinule row; and the ventral surface of the tarsus is aligned with two subparallel rows of elongate setae.
Figure 6: Akrav israchanani, Levana Cave, Israel. Chelicerae, dorsal and ventral views.
The Levana Cave specimens (Fig. 7) comply with these three diagnostic characters, from an external lateral view.

**Pectines.** All specimens, from both the Ayyalon Cave (Fet, Soleglad & Zonstein, 2011: figs. 6–8, 22, 31; tabs. 2–3) and Levana Cave (Fig. 7), have pectines with
five teeth. The pectines in both populations have two anterior lamellae and a large basal triangular middle lamella.

**Chelal Fingers and Dentition.** Fet, Soleglad & Zonstein (2011: figs. 18, 20–21, 27–28) discussed in detail the unusual chelal fingers found in *A. israchanani*. The fingers are long and thin with the terminus of the fixed finger highly curved, extending beyond the distal tip of the movable finger and curving inward crossing the terminus of the movable finger. Two inner denticles (*ID*) are located on the curvature of the distal aspect of the fixed finger. The median denticle (*MD*) rows are oblique and significantly imbricated, numbering seven to nine rows. Of particular importance diagnostically, both fingers exhibit inner accessory (*IAD*) denticles. Fet, Soleglad & Zonstein (2011: 43: fig. 33) consider this arrangement of denticles on the two fingers very important in distinguishing *Akrav* from the “Typhlochactas clade” of chactoid scorpions found in Mexican caves, its closest relative. The specimens from the Levana Cave (Fig. 8) match the Ayyalon Cave specimens in all details discussed above.

**Trichobothrial Patterns.** The trichobothrial pattern of *Akrav israchanani* conforms to the Type C pattern and is orthobothriotaxic. However, Fet, Soleglad & Zonstein (2011: 34–37; figs. 12–17, 29) listed several
diagnostic characters for *Akrav* that involved specific locations of trichobothria and the presence of additional petite trichobothria (i.e., other than the three defined for Type C; i.e., chelal $Et_t$, $Esb$, and patellar $esb_2$): **femur** (three trichobothria): trichobothrium $e$ is located on the dorsal surface, not the external surface. **Patella** (19 trichobothria): on the dorsal surface trichobothrium $i$ is located on the dorsal surface (not in its usual position, the internal surface); on the ventral surface trichobothria $v_3$ is located on the ventral surface, $v_2$ on the ventroexternal ($VE_c$) carina, and $v_3$ on the external surface close to $VE_c$; on the external surface we find 13 trichobothria plus $v_3$. Of particular interest the $esb_1$-$esb_2$ series slants distally, where $esb_2$ is distal of $esb_1$. **Chela** (26 trichobothria): in addition to petite trichobothria $Et_t$ and $Esb$, three additional trichobothria are also petite: $Eb_1$, $db$, and $dsb$. On the internal surface trichobothria $ib$–$it$ are located basally, but not close to the articular
membrane of the movable finger. On the ventral surface trichobothria $V_1-V_2$ are distributed over the entire length of the chelal palm, where $V_1$ and $V_2$ are positioned quite close to each other, the distance between $V_2$ and $V_3$ is more than three times the distance between $V_1$ and $V_2$. The juncture of $V_1-V_2-V_3$ is straight, not angling towards the internal edge. On the external/dorsal surfaces $Db$ is located quite basally whereas $Dt$ is positioned distally on the palm/fixed finger juncture; the $db-dt$ and $eb-et$ series are positioned well on the fixed finger. For the Levana Cave specimens only three trichobothria series are determinable, the chelal $ib-it$ and $V_1-V_2$ series and the patellar $v_1-v_3$ series (Fig. 9). In all cases, these three series matched the descriptions presented above for the Ayyalon Cave specimens.

**Conclusions**

We detected no important structural differences between the specimens found in the Levana Cave and those described in detail by Fet, Soleglad & Zonstein (2011) from the neighboring Ayyalon Cave. We conclude that the dead Levana Cave specimens indeed belong to the same relict chactoid species, Akrav *israchanani*. No live specimens have been found in either cave.

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**References**


