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A NEW SPECIES OF *Pseudotrapelus* (AGAMIDAE, SAURIA) FROM AQABA, SOUTHERN JORDAN

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A new species of *Pseudotrapelus* from Aqaba, southern Jordan is described. It differs from *P. sinaitus* in four well developed separated preanal pores in males, 3rd toe much longer than 4th and 16% incorrect *p*-distance (COI). Taxonomic relationships between Arabian Peninsula *Pseudotrapelus* need further investigations.

Keywords: Squamata; Acrodonta; Agamidae; *Pseudotrapelus aqabensis*; new species; southern Jordan, Barcode.

INTRODUCTION

Agama sinaita was described by Heyden in 1827 from Sinai (Egypt). In the diagnosis of this species we can find that it has dorsal scales equal in size and six preanal pores; table of measurements shows that third toe is nearly the same length as forth.

Anderson (1901) studied six specimens of *Agama sinaita* from Lahej (Aden vicinity, south-west Yemen) and mentioned that they are differing from Sinaitic and Egyptian lizards in having large dorsal scales. But he considered this character just as local variation "which begins to show itself to the north at Medina, where the species is traced to the south from the Sinaitic Peninsula." Also he mentioned that "they have the third digit the longest" wrongly considering this character as typical for *Agama sinaita*.

In 1905 Tornier described agamas from Lahej as *Agama neumanni*. He mentioned that it is different from *Agama sinaita* in having enlarged scales in occipital region of the head, 4 preanal pores and third toe equal to the forth. In this description "third toe the longest" again was erroneously considered as typical for *Agama sinaita*.

Arnold (1980) studied 32 specimens (8 adults) of *Agama sinaita* from Dhofar and synonymized *Agama neumanni* with *Agama sinaita*. He did not mention the third and forth digits comparative length in studied material, but only followed the Tornier's description that *Agama neumanni* differs from *Agama sinaita* in "forth toe nearly as long as the third." Thus he stated again that the third digit in *Agama sinaita* is the longest.

Fritz and Schütte (1988) studied 15 specimens of *Agama sinaita* from northern Yemen and 10 specimens from UAE, Sudan, Jordan and Egypt and mentioned that Yemeni agamas have the third digit longer than the forth, while animals from Sinai have the third one which is equal to the forth; males usually have 4 preanal pores and females do not have pores at all or have less than two, while in other regions males have 6 and females 4 – 5. However they considered all this differences just as example of clinal variation sensu Mayr (1963) and agreed with Arnold (1980).

In his summarizing paper on lizards of Arabia Arnold (1986) again stated *Agama neumanni* as synonym of *Agama sinaita*. This opinion became accepted by all herpetologists studying Arabian herpetofauna, together with mistake that in *Agama sinaita* third digit is longer than forth one (Schätti and Gasperetti, 1994; Schätti and Desvoignes, 1999; Leviton, 1992; Schleich et. al., 1996; Disi and Böhme, 1996), that probably comes from Arnold (1901), despite the paper of Fritz and Schütte (1988).

In 1843 *Agama sinaita* was placed in the monotypic genus *Pseudotrapelus* by Fitzinger.

In 2002 Jiri Moravec described *Pseudotrapelus sinaitus werneri* from Basalt desert (southern Syria and northern Jordan). He studied 67 specimens of *Pseudotrapelus sinaitus* from Syria, Jordan, Israel and Sinai. However his morphology matrix grouping was based on the geographical and political boundaries. Taxon differs

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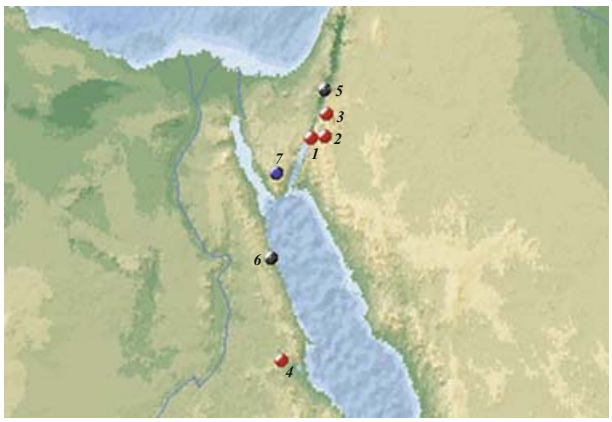

Fig. 1. Map showing localities of *P. sinaitus* sampled in this study, type territory marked by blue dot. Sequences localities marked by red dots: Jordan: *1*, Aqaba; *2*, Wadi Ram; *3*, Petra, Egypt: *4*, Azraq. Specimens without sequences: Jordan: *5*, Dead Sea cost, Egypt: *6* , Koseir; *7*, Sinai.

from *P. s. sinaitus* in some morphological details, including erroneous character of third and forth digits comparative length.

In 2010 Ananjeva et al. mentioned about *Pseudotrapelus sinaitus* from Aqaba (south-western Jordan) which differs from the other specimens from Jordan (Wadi Ram, Petra) based on COI mtDNA sequences difference (DNA-Barcoding). This specimen was considered as true *P. sinaitus* because it is geographically closer to the type territory of this species (Sinai) and because the third toe of this specimen was longer than forth one (character recently considered as diagnostic for *P. sinaitus*). More geographically distant specimens from south-east and central Jordan with equal length of the third and forth toes were considered as a new taxon.

In Melnikov et. al. (2011) this geographic confusion was corrected, because DNA sequences from south-west Egypt form a clade with south-east and central Jordan sequences (type territory of *P. sinaitus* is in between), but not with closer geographically specimen from Aqaba. This specimen was very well differentiated genetically from all remaining specimens (incorrect *p*-distance about 14%). Some diagnostic characters for this new taxon were proposed: bigger and more robust body size, different coloration of the ear region and different length ratio of the 3rd and 4th toes (Melnikov et al., 2011). Some comparative pictures of live specimens of these taxa were published by Ananjeva et al. (2010a).

Herein we describe this species of *Pseudotrapelus* from Aqaba as new.

MATERIAL AND METHODS

Morphological analysis. Type material examined: holotype of *Agama sinaita* (SMF 997, photo Günther Köhler); holotype[4] and paratypes of *Agama neumanni* (ZMB 27418, 37225, 54522, and 54523, photo Frank Tillack; NMW 23341, photo Heinz Grillitsch); holotype of *P. s. werneri* (NMP6V 34860/1, photo Jiri Moravec).

Other material. *P. sinaitus*: Egypt: ZISP 4817-18 — male and female, Koseir, 1878, coll.: Klunzinger; ZISP 8592 — male, Sinai, coll.: ?. ZISP 19526 — 2 males, Agypten: Sinai-Halbinsel, 06.08.1911, coll.: G. Schrader. Jordan: ZISP 25024-25 — 2 males, north Jordan, east coast of the Dead Sea, "Amman beach," 30.10.2008, coll.: Daniel Melnikov and Roman Nazarov; ZISP 25026-27 — male and female, south Jordan, Wadi Rum, 23.10.2008, coll.: Daniel Melnikov and Roman Nazarov; ZISP 25028 — female, central Jordan, Wadi Musa, Petra, 25.10.2008, coll.: Daniel Melnikov and Roman Nazarov; ZISP 26382 — male, south Jordan, Aqaba, 21.10.2008, coll.: Daniel Melnikov and Roman Nazarov.

Measurements. Scale counts and terminology follow Grandison (1968) fide Wagner and Bauer (2011), and measurements were taken with calipers to the nearest 0.1 mm. The following values were used: SVL, from tip of snout to cloaca; head width (HW), measured at the point of greatest width; head height (HH), measured at the point of greatest height; head length (HL), measured from behind the tip of retroarticular process to tip of snout; tail length (TL), measured from posterior lip of cloaca to tip of tail; supralabials (SL), number of all supralabial scales (not included interlabial); infralabials (IL), number of all sublabial scales, (not included interlabial); scales around midbody (SaM), number of scale rows around body midway between the limbs (at the kneels level); precloacal pores (PP), number of rows and number of pores in total; subdigital lamellae (SDL), number of lamellae under the fourth toe or finger, respectively (claw scale not included); ventral scales (VS), number of longitudinal ventral scales along midbody from shoulders to cloaca; dorsal scales (DS), number of longitudinal dorsal scales along midbody from shoulders to cloaca.

Molecular analysis. We obtained tissues for 8 specimens of *P. sinaitus* from Jordan and additionally used 2 sequences from Azraq, Egypt (Okajima, Kumazawa, 2010) (Fig. 1).

[4] Denzer et al. (1997 considered ZMB 27418 as holotype of *Agama neumanni* and other specimens as paratypes, but in the original description no specimen were designated as a holotype. Moreover specimen ZMB 27418 has no characters stated by Tornier as diagnostic for his species. The only specimen that has 4 preanal pores, equal length of 3rd and 4th toes and enlarged scales in occipital area is ZMB 42952 and this one should be considered as lectotype.

Fig. 2. Holotype of *P. aqabensis* ZISP 26382: *a*, general view from above; *b*, general view from below; *c*, head from above; *d*, head from side; *e*, head from front.

Original sequences were obtained from DNA-Barcoding program. The 658 base pair 5′ segment of the cytochrome oxidase subunit I (COI) gene (standard DNA Barcode region) was analyzed at the Canadian Centre for DNA Barcoding, Biodiversity Institute of Ontario, (Guelph, Canada). Whole genomic DNA from ethanol-preserved tissue was recovered using an automated DNA extraction method (Ivanova et al., 2006). PCR amplification for the standard DNA Barcode region of 657 bp using M13-tailed primer cocktails C_VF1LFt1 and C_VR1LRt1 (Ivanova et al., 2007). PCR products were sequenced using an ABI Prism BigDye Terminator v 3.1. Cycle Sequencing kit and analyzed on ABI 3730XL Genetic Analyzer (Hajibabaei et al., 2005). Bidirectional reads were assembled and manually edited in SEQSCAPE 2.1.1 software (Applied Biosystems).

Fig. 3. Coloration of holotype specimen *in situ* (*a*) and after capture (*b*).

Analysis of molecular data was performed using MEGA4 molecular genetic analysis software (Tamura et al., 2007). A distance-based tree was built with the Neighbour-Joining algorithm using the Maximum Composite Likelihood method. A character-based tree was inferred with the Maximum Parsimony method using the Close-Neighbour-Interchange algorithm with search level 7 in which the initial trees were obtained with the random addition of sequences (10 replicates). The tree was rooted with *Xenagama* (GenBank). There were a total of 654 positions in the final dataset, of which 107 were variable. In both methods branch support was assessed by bootstrapping with 1000 replicates.

RESULTS

Pseudotrapelus aqabensis sp. nov.

Holotype. ZISP 26382 (Fig. 2), adult male collected by Daniel Melnikov and Roman Nazarov 21.10.2008.

Type locality. Al Aqabah, southern Jordan.

Diagnosis. Slender species of *Pseudotrapelus* with 3rd toe much longer than 4th, four well developed separated preanal pores in males and no enlarged scales in the occipital area.

DNA Barcode of the holotype. BOLD (http://www.barcofinglife.org) sequence ID ZISP G070-09, process ID BM625-04.

Description of the holotype. ZISP 26382, adult male, tail broken 59 mm from the base.

Measurements. SVL 90 mm, HH 13.4 mm, HW 20.3 mm, HL 28 mm, length of left forelimb: 48 mm, length of left hind limb: 76 mm (including toes length).

Description. Head and body depressed. Nostril directed laterally and posterodorsally, pierced in the posterior lateral part of a large convex, smooth, pear-shaped nasal scale which is situated in depression in the beginning of the "canthus rostralis," that not developed well. Nasal scale visible from above separated from the first canthal scale by small scales. One enlarged globe-shaped scale in the frontal area between second pair of canthal scales, same size as nasal scales. Except enlarged nasal, frontal and canthal scales all other head scales are uniform, smooth, somewhat rectangular; interorbital scales as large than the supraorbital and temporal and occipital scales; imbrications of temporal scales not uniformly directed, partly ventrally, others posteriorly. Occipital very small, almost invisible; 16 (left) – 15 (1) (right) upper and 18 (left) – 17 (right) lower labial scales. Ear opening little smaller than eye, one single conical scale at the

Fig. 4. Habitat of *P. aqabensis* in the Aqaba vicinity with stone where holotype was captured.

front lower ear opening. Gular fold absent. Dorsal scales heterogeneous, longitudinal row of enlarged scales present, 120 scale rows around midbody, 70 dorsal scales along the vertebrate and 110 ventral scales along the belly between the anterior border of the shoulders and cloaca. One row of four separated precloacal pores. Dorsal body scales slightly keeled, with a keel extending along the entire scale, not mucronate. Gular scales smooth, ventral scales smooth. Hind limb long, toes reaching to the eye when adpressed. The third toe is longest, reaching 11 mm. Lamellae 10 under the left fourth finger, 13 lamellae under the left fourth toe. Forelimb long, digits reaching to the cloaca when adpressed. In the manus middle digit is the longest, reaching 8 mm. Tail little depressed at its base, with small pit after the cloaca, broken 59 mm behind cloaca. Large hemipeneal pockets absent, but two small bulges at the each side of the pit are present. Dorsal tail scales slightly keeled, somewhat larger than the body scales. Ventral tail scales strongly keeled, mucronate. Tail scales arranged in whorls.

Coloration (after ethanol preservation). Upper parts of the body are grayish, except head and arms that are grayish-bluish, a pale vertebral stripe from just behind the occiput along the body is visible. A small dark oval patch in the both lateral neck folds is visible. Throat, breast and arms are grayish-bluish other ventral parts of the body are whitish.

Coloration in life. General coloration is brownish, little yellowish in the head, neck and shoulders area (Fig. 3). There are three dark transverse bands on the body: on the neck, between arms and between thighs. Tail also with close dark transverse bands. After capture coloration of the head, neck and shoulder area became bluish.

Etymology. Named after the place where new species was found — Aqaba.

Natural history. Specimen was found in outcrops on the south-east edge of the Aqaba city (Fig. 4) together with *Pristurus rupestris* Blanford, 1874; *Echis coloratus* Gunther, 1978; *Ptyodactylus hasselquistii* (Donndorff, 1798) and *Cyrtopodion scabrum* (Heyden, 1827).

Distribution. This taxon known only from Aqaba, southern Jordan. However we found in the Internet its pictures from adjacent region of southern Israel (Fig. 5). We expect to record this species also in north-western Saudi Arabia.

Probably *P. sinaitus* also has penetration to northern Saudia from Basalt desert of Jordan and Syria. In northern Saudi Arabia there are probably two lines of *Pseudotrapelus*, as it shown on the map from Sindaco and

Fig. 5. *P. aqabensis* from Eilat vicinity, S Israel. Photo by Aviad Bar (*a*) and Henrik Bringsøe (*b*).

Fig. 6. Differences in comparative length of third and forth digits in the type specimens of *P. sinaitus* (*a*, photo by Günther Köhler), *P. neumanni* (*b*, photo by Frank Tillack), *P. s. werneri* (*c*, photo by Jiri Moravec), and *P. aqabensis* (*d*).

Eremchenko (2008). Taxonomic relationships and distribution of Arabian Peninsula *Pseudotrapelus* need further investigations.

Morphological Comparisons

Difference in comparative length of third and fourth toes. Comparison of comparative length of third and forth toes of studied type specimens (Fig. 6) shows that only *P. aqabensis* has the longest third toe.

The same comparisons of material from distribution area of *P. sinaitus*: Jordan, Sinai and Africa (Fig. 7) show clearly that this species has equal length of third and forth toes.

Strictly following to the Tornier's description *P. neumanni* also has equal length of third and forth toes.

Difference in number, position and morphology of the precloacal pores. Comparison of preanal pores number and position in studied type specimens (Fig. 8, all of them are males) shows that *P. neumanni* and *P. aqabensis* types have four well developed preanal pores separated from each other by gaps while type specimens of both *P. sinaitus* subspecies have six pores grouped in one row without gaps.

Comparative analysis of males and females preanal pore number and order in studied specimens from Jordan,

Fig. 7. Comparative length of the 3rd and 4th toes in *P. aqabensis* and *P. sinaitus* from different localities of Jordan.

Fig. 8. Comparison of preanal pores in the type specimens of *P. sinaitus* (*a*, first pore are removed, photo by Günther Köhler), *P. neumanni* (*b*, photo by Frank Tillack), *P. s. werneri* (*c*, photo by Jiri Moravec), and *P. aqabensis* (*d*).

Fig. 9. Sexual dimorphism in *P. sinaitus* from different localities comparing to male of *P. aqabensis*. Males are upper row, females — lower (except male of *P. aqabensis*).

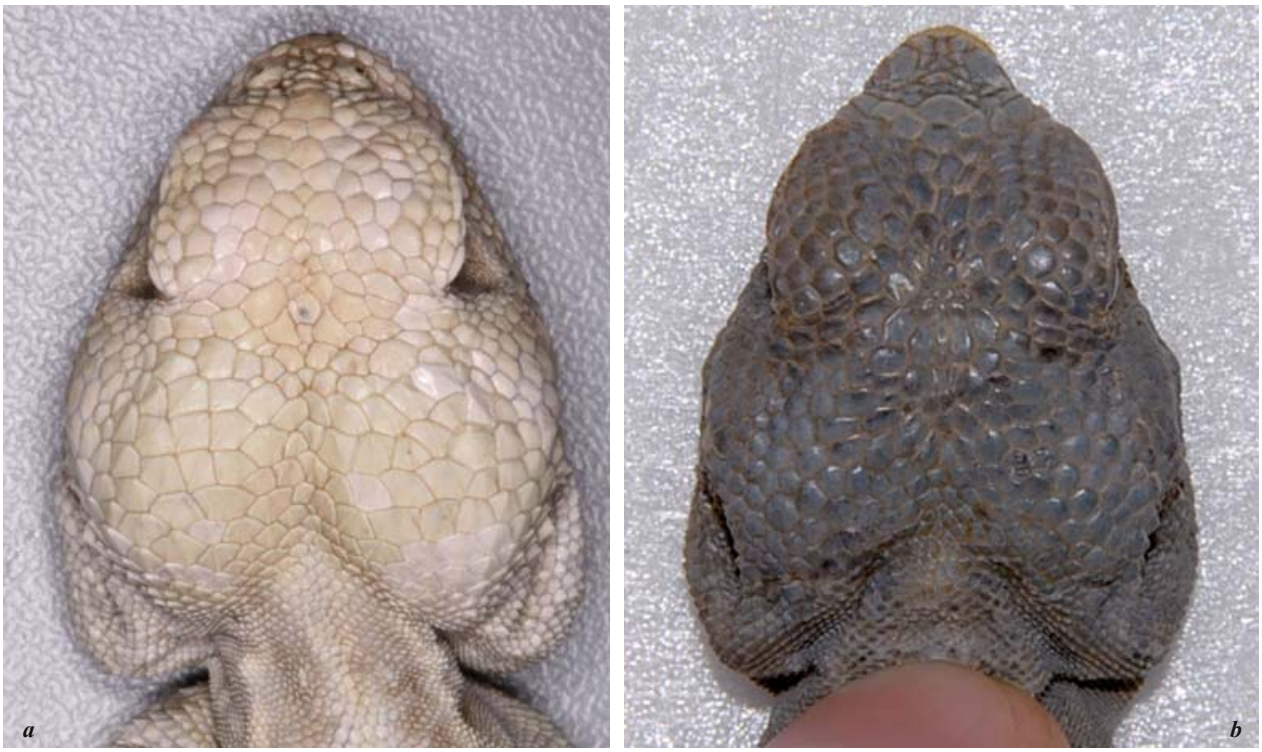

Fig. 10. Head scalation in the type specimens of *P. neumanni* (*a*, photo by Frank Tillack) and *P. aqabensis* (*b*).

Sinai and Africa (Fig. 9) demonstrates that males of *P. sinaitus* have 6 unseparated well developed pores, females usually have 4 small separated pores. The male of *P. aqabensis* has 4 well developed (like in *P. sinaitus* males) precloacal pores, but separated by gaps from each other (like in *P. sinaitus* females). Because of it we were doubted about the sex of the holotype and dissect the specimen to confirm our sex determination.

Moreover morphology of this precloacal pores seems to be different. In *P. sinaitus* pores are prominent while in *P. aqabensis* they are depressed. Further histological investigations needed to clarify our assumption.

Difference in the head scalation. All studied specimens of *P. sinaitus* from Africa, Sinai and Jordan have no enlarged scales in the occipital area of the head. *P. aqabensis* also has small equal size scales in this area (Fig. 10). Only in *P. neumanni* scales in the occipital area are enlarged, it is a diagnostic character of this species (Fig. 10). In Arabia this character "begin to increase in size south of Jeddah reaching their maximum dimensions in the Aden area; eastwards from here, size decreases again and in Hadhramaut and beyond is not larger than in north-west Arabia." This sentence from Arnold (1980) we consider as outlining of distribution boundaries of

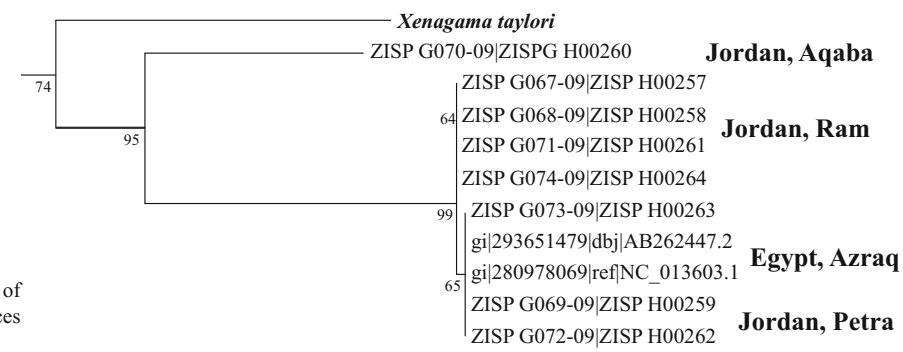

Fig. 11. Phylogenetic relationships of *Pseudotrapelus* based on mtDNA sequences (COI) by NJ.

Fig. 12. General view of the type specimens of *P. sinaitus* from Sinai (*a*, photo by Günther Köhler), *P. neumanni* from Yemen (*b*, photo by Frank Tillack), *P. s. werneri* from Syria (*c*, photo by Jiri Moravec), and *P. aqabensis* from southern Jordan (*d*).

P. neumanni. Based from this we suppose that *P. aqabensis* distributed from Aqaba to north of Jeddah.

Molecular Comparisons

Sequences of *P. sinaitus* from our northernmost sample (Petra, Jordan) and southernmost one (Azraq, Egypt) separated by 1000 km, almost have no genetic differences (Fig. 11). However sequences of samples from closest localities Aqaba (*P. aqabensis*) and Wadi Ram (*P. sinaitus*), separated only by 40 km, have 16% incorrect *p*-distance that much exceed species level.

Taxonomic Conclusion

Genus *Pseudotrapelus* consists of two valid species — *P. sinaitus* and *P. aqabensis*. *P. sinaitus* is distributed in Africa, Sinai, Jordan, Israel, Syria with subspecies *P. s. werneri* in Basalt Desert, that different from nominative subspecies in some morphological details. *P. aqabensis* known only from the type locality (Fig. 12). Taxonomic status of *P. neumanni*, that we provisionally consider as a valid species, together with other Arabian Peninsula *Pseudotrapelus* need further investigation. At the moment we have a mix of morphological characters of *Pseudotrapelus* from Arabia, because details of these characters (for example, separated or not separated preanal pores), sexual dimorphism, detailed locality data and possibility of sympathrical distribution of different forms were not taken into account in recent reports as Kowalski and Grossmannn (2011) and Dieckmann (2011).

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