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A new species of *Mesalina* (Reptilia: Lacertidae) from Abd al-Kuri, Socotra Archipelago, Yemen, and a preliminary molecular phylogeny for the genus *Mesalina*

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Abstract: Morphological and molecular data (mitochondrial rRNA sequences) suggest that the *Mesalina* population from Abd al-Kuri Island represents an endemic species, clearly different from *M. balfouri* that inhabits Socotra and Samha. *Mesalina kuri* n. sp. is described. Morphologically it is more similar to *M. olivieri* than to *M. guttulata*, whereas *M. balfouri* shares more characters with *M. guttulata*. The molecular trees do not confirm any close relationship of the Socotran *Mesalina* with the above named species, but show the southern Arabian *M. adramitana* as the closest mainland species. *Mesalina olivieri* appears as a sister species to the African *M. rubropunctata* in the most parsimonious tree.

نوع جديد من *Mesalina* (الزواحف: السحليات) من جزيرة عبد الكوري، أرخبيل سوقطرة، اليمن مع دراسة جزيئية أولية للتطور النوعي للجنس *Mesalina*

اورليخ يوجر و ورنر ماير

خلاصة: تبدي النتائج الشكلية والجزيئية (تسلسل حمض rRNA الميتوكوندري) أن جماعة *Mesalina* من جزيرة عبد الكوري تمثل نوعاً متوطناً يختلف تماماً عن النوع *M. balfouri* الذي يعيش في جزيرتي سوقطرة وسمحة. تم وصف النوع الجديد *Mesalina kuri* . ومن الناحية الشكلية يشبه هذا النوع الجديد النوع *M. olivieri* اكثر من النوع *M. guttulata*، بينما يشترك النوع *M. balfouri* بصفات أكثر مع النوع *M. guttulata*. لا تؤكد تفرعات الشجرة الجزئيية أية علاقة قرابة بين النوع الذي يعيش في جزيرة سوقطرة مع الأنواع التي تم ذكرها آنفاً، إلا أنها تظهر علاقة قرابة مع النوع *M. adramitana* الذي يعيش في البر الرئيسي من جنوب شبه الجزيرة العربية. ويبدو أن النوع *Mesalina olivieri* نوع شقيق للنوع *M. rubropunctata* الأفريقي المشابه.

INTRODUCTION

The genus *Mesalina* Gray, 1863 has a typical Saharo-Sindian distribution, contrary to its sister genus *Eremias* Wiegmann, 1834, which inhabits arid regions of temperate central Asia. *Mesalina balfouri* (Blanford, 1881) is the only lacertid currently recognised among the reptiles of the Socotra Archipelago (JOGER 1999). BOULENGER (1887) synonymised it with *Mesalina guttulata* (Lichtenstein, 1823), a widespread species inhabiting most of northern Africa, Arabia and the arid Middle East. HAAS (1951) however, while resurrecting the North African species *Mesalina olivieri* (Audouin,

1829), transferred *M. balfouri* to the latter as a subspecies *M. o. balfouri*. Having compared the hemipenes of all three taxa, ARNOLD (1986 a) concluded that *M. balfouri* was a different species, endemic to the Socotra Archipelago. It has been recorded from Socotra Island as well as from the smaller islands, Samha and Abd al-Kuri (WRANIK 1998).

During a faunal survey in February 1999, carried out as part of the UNDP/GEF project "Conservation and Sustainable Use of the Biodiversity of Socotra Archipelago", specimens were collected from Socotra, Samha and Abd al-Kuri by U. Joger. Additional specimens were collected by H. Rösler and W. Wranik during the same multidisciplinary expedition. Given the fact that the gekkonid lizards of Abd al-Kuri are endemic species, and that the *Mesalina* of that westernmost island of the archipelago had a different colour pattern from those from the other two islands, we decided to compare these lizards morphologically and genetically with each other, and with a variety of mainland species, in order to establish a taxonomy which reflects the evolutionary history of the group.

Abbreviations:

BMNH	The Natural History Museum, London
HLMD	Hessisches Landesmuseum Darmstadt
MNHN	Muséum National d'Histoire Naturelle, Paris
MNB	Museum für Naturkunde, Berlin
MTKD	Staatliches Museum für Tierkunde Dresden
NMW	Naturhistorisches Museum Wien

MATERIALS AND METHODS

Museum specimens examined

From the following specimens, standard morphological data were taken.

Mesalina balfouri (Blanford, 1881): Yemen, Socotra Island: BMNH 81.7.22.8-11 (type series); Dahamis, BMNH 99.12.76; Jena-Agahan, BMNH 99.12.5.77-78; Homhil, BMNH 99.12.5.79-80; Hadibo, BMNH 1953.1.8.10-15; Socotra, BMNH 1957.1.9.82-83; Kishan, BMNH 1957.1.9.84; Hadibo Plain, BMNH 1967.511-513; Kalansiya, BMNH 1967.514; Sha'ab Bay, HLMD-RA-2799; east of Hadibo, HLMD-RA-2797-98; Socotra, MNB 59231-233; Hakari, NMW 12077 1-3.

Mesalina sp.: Yemen, Samha Island, west coast, HLMD-RA-2793-95. (for specimens from Abd al-Kuri see type specimens below).

Mesalina adramitana (Boulenger, 1917): United Arab Emirates: Sharjah, BMNH 1973.2056-2059. — Oman: Dauqna, 1976.1468, 1471.

Mesalina ayunensis Arnold, 1980: Oman: Hajir al Dhagmar, BMNH 1996.396.

Mesalina brevirostris Blanford, 1874: Bahrain: BMNH 1971.100, 105, 107, 108.

Mesalina guttulata (Lichtenstein, 1823): Saudi Arabia: Sudah, Asir, BMNH 1977.424; Al Khodra, BMNH 1986.663-664. — Egypt: HLMD-RA-2377-2378.

Mesalina martini (Boulenger, 1897): Djibouti: MNHN 1893.139-140. — Somalia (former British Somaliland): Borama District, BMNH 1937.12.5.493-498.

Mesalina olivieri (Audouin, 1829): Egypt: NMW 12081. — Sinai, NMW 12069: 1-3. — Palestine: Beersheba, NMW 12071; Revivim, 16154.

Tissue samples

For the molecular study we investigated samples from the following specimens (localities in parentheses). Two types of tissue were used: tissue from ethanol-preserved study specimens from museum collections and deep-frozen tissue of the heart and the lung.

Mesalina balfouri (Yemen: Socotra)
Mesalina sp. (Yemen: Samha Island)
Mesalina sp. (Yemen: Abd al-Kuri Island)
Mesalina adramitana (United Arab Emirates: Layn)
Mesalina brevirostris (United Arab Emirates: Abu Dhabi)
Mesalina guttulata (Tunisia: Tamerza)
Mesalina rubropunctata (Egypt: Hurghada)
Mesalina olivieri (Egypt: locality unknown)

Outgroup taxa:

Eremias pleskei Bedriaga, 1907 (Armenia: Vedi)
Eremias arguta Pallas, 1773 (Ukraine: locality unknown)

DNA analysis

Our protocols for DNA purification and PCR amplification (parts of mitochondrial genes for 12S and 16S-rRNA) were reported in detail by MAYER et al (2000). Sequencing of about 460 bp of the 12S gene and about 490 bp of the 16S gene was performed by MWG-Biotech (Ebersberg, Germany). The sequences are registered under the GenBank accession numbers AY035824 to AY035843.

The alignment of the combined 12S and 16S sequences was produced with the program Clustal X (THOMSON et al. 1997) and corrected manually. The analysis resulted in an overall alignment of 957 positions; two segments (together 14 positions), which could not be aligned unambiguously, were excluded from the analysis. A neighbour joining tree (p-distances) was calculated by Clustal X while the maximum parsimony dendrograms were produced using the PAUP® program package version 4.0b3a (SWOFFORD 1997).

RESULTS

Morphological comparisons

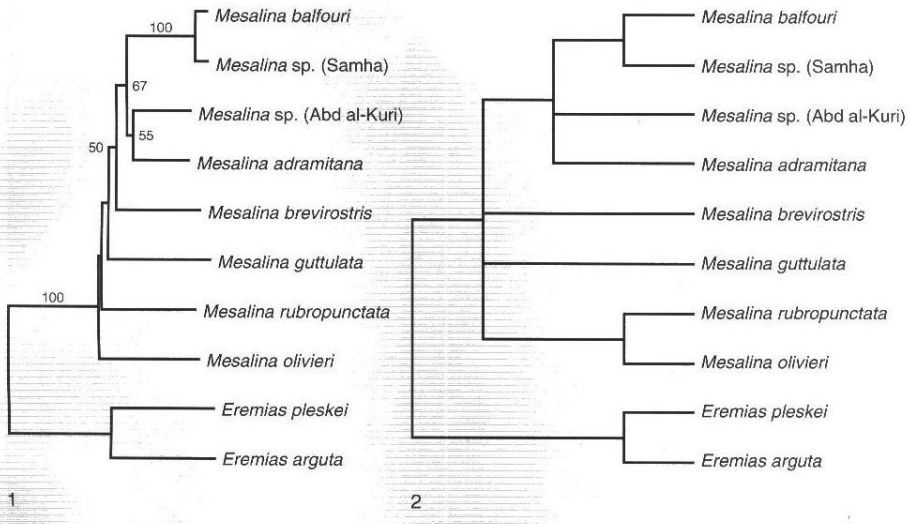
Table 1 gives the morphological characteristics of the *Mesalina* specimens from Abd al-Kuri. A direct comparison with *M. balfouri* from Socotra (and Samha) is given in Table 2. The lizards from Abd al-Kuri have a palpebral disk which is subdivided into several subequal scales like the one in *M. olivieri*, whereas those from Socotra and Samha have a *M. guttulata*-type eyelid with two large transparent scales among several very small ones. In lizards from Abd al-Kuri, the palpebral disk bears traces of pigment, whereas those from Socotra and Samha are not pigmented. Another clear difference is that the scales on top of the tibia are keeled in lizards from Socotra and Samha, but unkeeled in those from Abd al-Kuri. The latter have a different colour pattern and a longer tail, whereas snout-vent length is approximately equal. The femoral pores, dorsal and ventral scale rows and the scales on top of the eye (row of small scales distal to the large plates) are all more numerous in the lizards from Abd al-Kuri.

Table 1: Morphological characteristics of *Mesalina* specimens from Abd al-Kuri Island. (tv) = transverse rows (from collar to groin); (r) = regenerated tail.

	HLMD-RA-2796	MTKD 41243	MTKD 41244	MTKD 41245	MTKD 41246	NMW 12072: 1	NMW 12072: 2	NMW 12072: 3	NMW 12072: 4	NMW 12072: 5	BMNH 1967-515	Range
Gender	♀	♂	♂	♂	?	♀	♀	♀	♂	♂	♀	
Upper labials	8, 8	7, 7	9, 10	9, 9	8, 8	9, 9	10, 10	8, 9	10, 9	8, 9	8, 8	7-10
Lower labials	7, 7	6, 7	6, 7	7, 8	6, 6	7, 7	7, 9	8, 7	7, 7	8, 7	7, 7	6-9
Scales on collar	9	10	12	11	10	11	10	10	10	10	10	9-12
Ventral scale rows	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)	8 (10)
Ventral scales (tv)	27	30	29	29	32	27	27	28	27	27	27	27-32
Dorsal scale rows	46	44	44	47	46	46	45	47	47	52	46	44-52
Scales under fourth finger	16	17	17	15	16	19	18	17	18	16	18	15-19
Scales under fourth toe	24	26	25	23	25	24	24	22	23	23	24	22-26
Scales on eyelid	9, 12	13, 13	12, 13	13, 14	11, 11	13, 13	14, 14	13, 13	12, 13	11, 12	12, 12	9-14
Femoral pores	16/16	15/16	16/16	16/16	15/16	14/15	13/15	13/14	16/17	15/16	14/14	13-17
Occipital scale present	+	+	+	+	+	+	–	+	+	+	–	
Parietals in contact	+	–	+	+	+	–	+	+	+	–	+	
Snout-vent length	46	57	56	52	40	51	50	53	54	52	53	
Tail length	100	96	91	106	89	61 (r)	100	81	115	72 (r)	65 (r)	

Table 2: Comparison between *Mesalina balfouri* (Socotra and Samha islands, n = 38) and *M. kuri* n. sp. (Abd al-Kuri Island, n = 11).

Character	*Mesalina balfouri*	*Mesalina kuri* n. sp.
Scalation of palpebral disk	2 large transparent, non-pigmented scales among smaller ones	5 or more medium-sized, pigmented scales
Scales on top of tibia	Keeled	Unkeeled
Colour pattern	Broad dark dorsolateral lines, bordered by white lines, broad brown mid-dorsal band	No continuous dark dorsolateral lines, but rows of dark spots alternating with white lines, grey mid-dorsal band
	Pattern present in both sexes	Pattern reduced in males
Maximum snout-vent length	♂ 58 mm, ♀ 54 mm	♂ 57 mm, ♀ 53 mm
Maximum tail length	♂ 102 mm, ♀ 85 mm	♂ 115 mm, ♀ 100 mm
Tail length to snout-vent length	Usually shorter than twice snout-vent length	Usually longer than twice snout-vent length
Femoral pores	Usually less than 30 (exceptionally 32)	Usually more than 26 (up to 34)
Dorsal scale count	36-44	44-52
Ventral scale count (collar to groin)	(22) 24-27 (29)	27-32
Small scales on top of eye	9-12	11-14



Figs 1-2: 1: Neighbour joining tree of 12S and 16S rRNA sequences (combined) of *Mesalina* species. Bootstraps values of 2000 replicates (if 50 or higher) are indicated. 2: Maximum parsimony tree of 12S and 16S rRNA sequences (combined) of *Mesalina* species. Strict consensus of 7 trees of equal length.

DNA sequencing

The sequence divergence (p-distance) between the samples from Socotra and Samha is comparatively low (1.2 %) indicating that both populations are very closely related. All other sequence differences between *Mesalina* samples range from 6 to 10 %. The sample from Abd al-Kuri shows the smallest differences to Socotra and Samha samples as well as to the *M. adramitana* sample (about 6 %).

The maximum parsimony analysis (Heuristic Search, gaps are treated as fifth character state) resulted in seven equivalent most parsimonious trees with a length of 473 steps; the number of informative characters is 163. The strict consensus tree and the neighbour joining tree are represented in Figures 1 and 2, respectively. One cluster, which is found in both dendrograms, consists of *M. balfouri* from Socotra and Samha as well as *Mesalina* sp. from Abd al-Kuri and *M. adramitana*. Additionally, in the maximum parsimony tree *M. olivieri* and *M. rubropunctata* cluster together.

CONCLUSIONS

The *Mesalina* from Samha Island does not differ significantly from *M. balfouri* morphologically, and their genetic distance is low. We therefore conclude that these two islands bear the same species. However, the genetic and morphological differences of the Abd al-Kuri population from all other *Mesalina* are, without doubt, as large as the differences usually found between separate species. Therefore we are describing it as a new species.

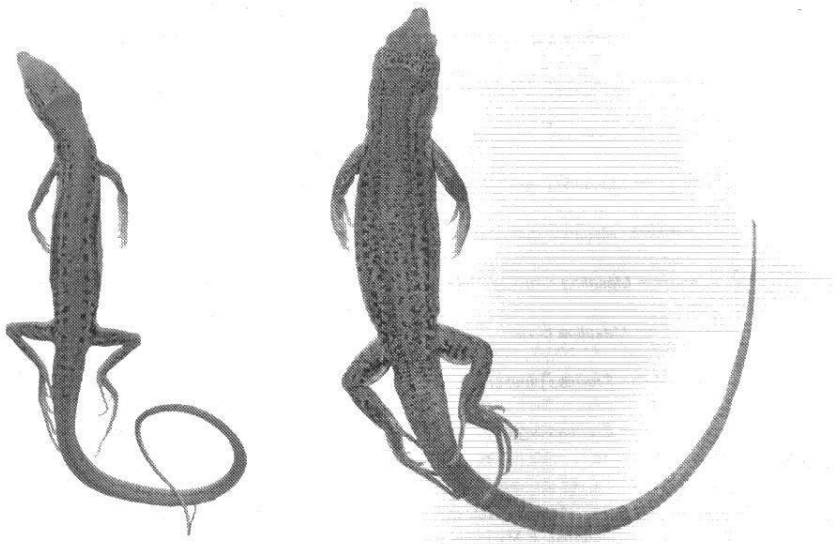


Fig. 3: Holotype (♀) and one paratype (♂) of *Mesalina kuri* n. sp.

Mesalina kuri n. sp. Fig. 3

Holotype: ♀, Abd al-Kuri Island, Yemen, west coast, 12°11'N 53°14'E, U. Joger, 18.II.1999, HLMD-RA-2796-HT. — Paratypes: Yemen, Abd al-Kuri Island: 10 spms, 1967, K. Guichard, BMNH 1967-515; 1999, H. Rösler & W. Wranik, MTKD 41243-46; 1898/1899, Simony, NMW 12072 1-5.

Diagnosis: A large-bodied *Mesalina*, with the tail longer than twice the snout-vent length; unkeeled scales on top of the tibia; five or more slightly pigmented scales of equal size in the palpebral disk of the eyelid; a dorsal colour pattern lacking continuous dark lines, with 44-52 dorsal scale rows.

Description of holotype (Fig. 3): Female of 46 mm snout-vent length, head length 11 mm, body length 35 mm, tail length 100 mm. Length of right foreleg (including fingers) 16 mm; length of right hind leg (including toes) 27 mm. Head width 7 mm, distance of snout tip to eye 5 mm. Seven lower labials and eight upper labials on both sides, fifth upper labial underneath eye. Nine scales along collar; eight clearly distinguished longitudinal ventral scale rows plus one smaller ventrolateral scale on each side. Number of transverse ventral scale rows 27 (counted from collar to groin); 46 dorsal scale rows around mid-body; 16 scales under fourth finger, 24 scales under fourth toe.

Scales on top of eye: 2 large central and 2 medium-sized outer supraoculars, accompanied distally by a row of smaller scales composed of 12 scales on the left and 9 scales on the right. Frontonasal scale meets the rostral; parietals meet each other, although a large interparietal and a small triangular occipital scale are present.

Thirty-two femoral pores (16 on each side).

Colour pattern (in alcohol): Upper side of head light brown; some black spots on the interparietal and on the parietals; lateral margins of parietals blackish. Sides of head whitish, with

Plate 1: View of the type locality of *Mesalina kuri* n. sp.

two dark lateral streaks, one from eye to upper ear opening, the other from fifth labial to anterior ear opening. Dorsal colour light greyish brown medially, with the following alternating pattern elements from the vertebral area to the lateral fold: a row of little white spots, a row of small blackish spots, a thin white line and a thin row of black streaks interrupted by little white spots. Venter and underside of head and tail uniform whitish. Tail grey above, with a thin black vertebral line and a lateral row of black spots. Hind legs with ocellae-like white-centred spots; forelegs more or less uniform grey.

Variation: Adult males are more stoutly built than the females, with particularly broad heads and necks. With age, their dorsal coloration becomes more uniform with alternating but indistinct light brown and grey longitudinal stripes and many black dots, which also cover sides and parietal area of head. Contrary to the holotype, most specimens have the frontonasal separated from the rostral by the nasal scales, which meet each other. An occipital scale may be absent or present. See Table 1 for scale counts of the paratypes.

Habitat: The 1999 type series was captured among scarce bushy vegetation on a sandy beach (Plate 1). The species was not seen at higher elevations.

Affinities: The morphological differences between the *Mesalina* from Socotra and from Abd al-Kuri are so great that an affiliation with different mainland species seems more plausible than a common ancestor on the archipelago.

Two large eyelid windows, an important diagnostic character in *Mesalina*, associate *M. balfouri* with *M. guttulata*, which also shares with *M. balfouri* the presence of keels on the scales on the upper surface of the tibia. *Mesalina kuri* n. sp., on the other hand, is similar to *M. olivieri* and *M. martini* in having the palpebral disk further subdivided. The molecular analysis, however, does not

confirm any close relationship between *M. guttulata,* or *M. olivieri*, and any of the island *Mesalina*. Instead, according to the mitochondrial rRNA sequences, *M. adramitana* seems to be the closest related mainland species. *Mesalina adramitana* is a species with two large eyelid windows as well, but it lacks pronounced keels on the tibia scales. It is much smaller than *M. balfouri* (maximum snout-vent length 43 mm) and has the two median rows of ventral scales narrowed. Its sister species may be *M. ayunensis* (see ARNOLD 1986 b), which was not available for molecular studies. As these species are both south Arabian, an ancestral *Mesalina* could have colonised Socotra from the north (Arabia) rather than from the west (Africa). In the maximum parsimony tree (Fig. 2), the two African taxa (*M. olivieri* and *M. rubropunctata*) represent a separate group.

Unfortunately we did not have a sample of *M. martini*, an inhabitant of both south-west Arabia and East Africa (Sudan to Somalia) for molecular analysis. *Mesalina martini* would be a possible candidate for a sister group relationship with *Mesalina kuri*, from which it nevertheless differs in having keeled scales on the tibia and in scale counts (Table 3).

Table 3: Comparison between *Mesalina martini* (Djibouti, n = 7) and *M. kuri* n. sp. (Abd al-Kuri, n = 11).

Character	*Mesalina martini*	*Mesalina kuri* n. sp.
Ventral count (collar to groin)	29-37	27-32
Dorsal scale rows	32-40	44-52
Scales under fourth finger	13-16	(15) 16-18 (19)
Scales on top of tibia	Keeled	Unkeeled
Femoral pores (one side)	12-14	(13) 15-16 (17)

Key to Arabian species of the genus *Mesalina*
(excluding species which are still undescribed, see ARNOLD 1986 b)

1	Scales on tibia distinctly keeled	2
–	Scales on tibia unkeeled or very slightly keeled (*M. ayunensis*)	5
2	One or two large transparent windows in palpebral disk	3
–	Palpebral disk divided into several semi-transparent scales more or less equal in size	4
3	35-44 dorsal scale rows, maximum snout-vent length 58 mm ***M. balfouri*** (Socotra and Samha islands)	
–	43-47 dorsal scale rows, maximum snout-vent length 42 mm ***M. guttulata*** (North Africa, Arabia)	
4	Broad dark band along middle of back present ***M. olivieri*** (North Africa, northern Arabia)	
–	Broad dark band along middle of back absent ***M. martini*** (SW Arabia, Sudan to Somalia)	
5	Palpebral disk divided into several slightly pigmented scales more or less equal in size ***M. kuri*** n. sp. (Abd al-Kuri Island)	
–	Palpebral disk with one or two large transparent scales	6
6	12 ventral scale rows	7
–	8-10 ventral scale rows	8
7	Small lizard (maximum 43 mm snout-vent) with long, pointed snout, median rows of ventrals narrower than others ***M. adramitana*** (southern Arabia)	
–	Large lizard with short snout, all ventral scale rows equal in size ***M. brevirostris*** (northern Arabia to Pakistan)	

8 More than 40 dorsal scale rows, more than 30 femoral pores
M. ayunensis (Dhofar)

– Fewer than 40 dorsal scale rows, fewer than 30 femoral pores
M. adramitana (southern Arabia)

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