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

Ulrich Joger and Werner Mayer

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 Samba. 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.

النوع الجديد من Mesalina (الزواحف: السحلية) من جزيرة عبد الكوري، أرخبيل Socotra، اليمن مع دراسة جزيئية أولية للتطور النموذجي للجنس Mesalina

اورنر يوجر و وينر ماير

خلاصة: تبدو النتائج الشكلية والجزيئية (من سلسلة حمض RNA من النوكليوز) أن جماعة Abd al-Kuri الكوري تمثل نوعاً متواناً ينتمي تماماً إلى النوع M. balfouri الذي يعيش في جزيرة Socotra جنوب شرقية. تم وصف نوع جديد من Mesalina kuri من الناحية الشكلية، لكن هذه النوع الجديد ل Mesalina على تطابق أكثر مع النوع M. guttulata، بينما يشكل النوع M. balfouri تفاعلات أكثر مع النوع M. guttulata. تحتوي الجرائنية النمطية علاقة قديمة بين النوع الذي يعيش في جزيرة Socotra مع الأنماط التي تم ذكرها أثناء إصدار طبقات هذه الجرائنية العربية. ويعتقد أن النوع M. rubropunctata نوع شائع للنوع Mesalina olivieri

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, 1825), 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. balfoi* to the latter as a subspecies *M. a. balfoi*. Having compared the hemipenes of all three taxa, Arnold (1986a) concluded that *M. balfoi* 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 (Wränk 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. Wränk 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* sp.: Yemen, Samha Island, west coast, HLMD-RA-2793-95. (for specimens from Abd al-Kuri see type specimens below).


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.

*Meulina bahiari* (Yemen: Socotra)
*Meulina sp.* (Yemen: Samha Island)
*Meulina sp.* (Yemen: Abd al-Kuri Island)
*Meulina adrianstana* (United Arab Emirates: Layn)
*Meulina brevirostris* (United Arab Emirates: Abu Dhabi)
*Meulina guttulata* (Tunisia: Tanortza)
*Meulina rubropunctata* (Egypt: Hurghada)
*Meulina olivieri* (Egypt: locality unknown)

Outgroup taxa:
*Eremias pleskei* Bedriaga, 1907 (Armenia: Vedi)
*Eremias argus* 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 Mater 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 (Thompson 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. bahiari* 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 snout are keeled in lizards from Socotra and Samha, but unkeeled in those from Abd al-Kuri. The latter have a different color pattern and a longer tail, whereas snout-vent length is approximately equal. The femoral pores, dorsal and ventral scales 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. (cv) = transverse rows (from collar to groin); (c) = regenerated tail.

<table>
<thead>
<tr>
<th>Gender</th>
<th>ILAM6-Ka-2796</th>
<th>MTKRD-41243</th>
<th>MTKRD-41244</th>
<th>MTKRD-41245</th>
<th>MNW 12002.1</th>
<th>MNW 12002.2</th>
<th>MNW 12002.3</th>
<th>MNW 12002.4</th>
<th>NAM 12002.3</th>
<th>NAM 12002.4</th>
<th>NAM 12002.5</th>
<th>Range:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper labials</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>7-10</td>
</tr>
<tr>
<td>Lower labials</td>
<td>7.7</td>
<td>6.7</td>
<td>7.8</td>
<td>7.8</td>
<td>7.7</td>
<td>7.9</td>
<td>8.7</td>
<td>7.7</td>
<td>7.7</td>
<td>6.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scales on collar</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>9-12</td>
</tr>
<tr>
<td>Ventral scale rows</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td>8(10)</td>
<td></td>
</tr>
<tr>
<td>Ventral scales (cv)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>32</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>28</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Dorsal scale rows</td>
<td>46</td>
<td>44</td>
<td>47</td>
<td>46</td>
<td>45</td>
<td>42</td>
<td>52</td>
<td>46</td>
<td>44</td>
<td>52</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Scales under fourth finger</td>
<td>16</td>
<td>16</td>
<td>17</td>
<td>15</td>
<td>16</td>
<td>19</td>
<td>16</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Scales under fourth toe</td>
<td>24</td>
<td>26</td>
<td>25</td>
<td>23</td>
<td>25</td>
<td>24</td>
<td>23</td>
<td>24</td>
<td>22</td>
<td>23</td>
<td>23</td>
<td>22-26</td>
</tr>
<tr>
<td>Scales on eyelid</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13-14</td>
</tr>
<tr>
<td>Femoral pores</td>
<td>16/16</td>
<td>16/16</td>
<td>16/16</td>
<td>16/16</td>
<td>14/15</td>
<td>13/15</td>
<td>13/15</td>
<td>13/15</td>
<td>16/16</td>
<td>15/16</td>
<td>15/16</td>
<td>13-17</td>
</tr>
<tr>
<td>Occipital scale present</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Parietals in contact</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Snout-vent length</td>
<td>46</td>
<td>57</td>
<td>56</td>
<td>52</td>
<td>40</td>
<td>51</td>
<td>50</td>
<td>53</td>
<td>54</td>
<td>52</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Tail length</td>
<td>100</td>
<td>96</td>
<td>91</td>
<td>106</td>
<td>89</td>
<td>61(1)</td>
<td>100</td>
<td>81</td>
<td>115</td>
<td>72 (c)</td>
<td>65 (c)</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Character</th>
<th><em>Mesalina halfiari</em></th>
<th><em>Mesalina kuri</em> n. sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalation of palpebral disk</td>
<td>2 large transparent, non-pigmented scales among smaller ones</td>
<td>5 or more medium-sized, pigmented scales</td>
</tr>
<tr>
<td>Scales on top of tibia</td>
<td>Keeled</td>
<td>Unkeeled</td>
</tr>
<tr>
<td>Colour pattern</td>
<td>Broad dark dorso-lateral lines, bordered by white lines, broad brown mid-dorsal band</td>
<td>No continuous dark dorso-lateral lines, but rows of dark spots alternating with white lines, grey mid-dorsal band</td>
</tr>
<tr>
<td>Maximum snout-vent length</td>
<td>0.58 mm, 0.54 mm</td>
<td>0.57 mm, 0.53 mm</td>
</tr>
<tr>
<td>Maximum tail length</td>
<td>0.10 mm, 0.85 mm</td>
<td>0.115 mm, 0.100 mm</td>
</tr>
<tr>
<td>Tail length to snout-vent length</td>
<td>Usually shorter than twice snout-vent length</td>
<td>Usually longer than twice snout-vent length</td>
</tr>
<tr>
<td>Femoral pores</td>
<td>Usually less than 30 (exceptionally 32)</td>
<td>Usually more than 26 (up to 34)</td>
</tr>
<tr>
<td>Dorsal scale count</td>
<td>36-44</td>
<td>44-52</td>
</tr>
<tr>
<td>Ventral scale count (collar to groin)</td>
<td>(23) 24-27 (23)</td>
<td>27-32</td>
</tr>
<tr>
<td>Small scales on top of eye</td>
<td>9-12</td>
<td>11-14</td>
</tr>
</tbody>
</table>
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.
*Mesalina kuri* n. sp.

**Holotype:** Yemen, Abd al-Kuri Island, 12°11'N 53°14'E, U. Joger, 18. II. 1999, HLMD-RA-2796-171.


**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 190 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 supracaudals, 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
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 mediially, 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 frontal and nasal scales 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. admiratana* seems to be the closest related mainland species. *Mesalina admiratana* 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. balifouri* (maximum snout-vent length 43 mm) and has the two median rows of ventral scales narrowed. Its sister species may be *M. ayuenensis* (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. rubropanzata*) 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* = 1).**

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

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