# A new species of blind snake, *Xerotyphlops*, from Iran

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**ABSTRACT** - A new species of blind snake is described from Lorestan Province, western Iran. This is a cryptic species close to the *Xerotyphlops vermicularis* complex. It is readily distinguished by hemipenal characters. When everted the right hemipenis is coiled and the left is curved, in *X. vermicularis* both hemipenes are straight.

## INTRODUCTION

Three genera and five species of Typhlopidae, are distributed in Iran: *Indotyphlops braminus* (Daudin, 1803), *Myriopholis blanfordi* (Boulenger, 1890), *M. macrorhyncha* (Jan, 1860), *Xerotyphlops vermicularis* (Merrem, 1820), and *X. wilsoni* (Wall, 1908) (Uetz and Hallermann, 2016). The genus *Xerotyphlops* Hedges, Marion, Lipp, Marin & Vidal, 2014 is easily distinguishable from other related genera of the subfamily *Asiatyphlopinae* by having segmented testes and 7-13 subcaudals, as well as other traits described by Pyron and Wallach (2014). *Xerotyphlops* comprises four species (*X. etheridgei*, *X. socotranus*, *X. vermicularis*, and *X. wilsoni*). In the present study a new cryptic species of *Xerotyphlops* is described and compared to other typhlopid snakes of Iran.

## MATERIAL AND METHODS

Six specimens of a new *Xerotyphlops* were collected during field trips in March and May 2016 to the western slope of the central Zagros Mountains in western Iran (Fig. 1). All six specimens are included in the type series. They are now all deposited in the herpetological collections of the Paris Natural History Museum (MNHN-RA; France).

The specimens were compared with other members of *Xerotyphlops* using the original species descriptions and other publications containing morphological accounts of these snakes (Wall, 1908; Wallach, 2009; Afroosheh et al., 2012; Hedges et al., 2014; Pyron and Wallach, 2014). Characters were selected to facilitate comparisons with data from Pyron and Wallach (2014). Measurements were taken using a dial caliper with 0.01 mm precision.

**Data collected included the following:**
LSRab: longitudinal scale rows at anterior body; LSRmb: longitudinal scale rows at mid-body; LSRpb: longitudinal scale rows at posterior body; TSR: transverse scale rows at mid-body; SRR: scale row reduction (longitudinal or transverse); SC: subcaudals; LOA: total length (mm); W: mid-body diameter; TL: tail length; TW: mid-tail diameter; SIP: supralabial imbrication pattern; INS: inferior nasal suture contact with supralabials (1, 2), preocular (PO) or rostral (R); RW: mid-rostral width; HW: interocular head width; PO: postoculars; HP: everted hemipenes (S: straight; C: coiled); HPC: everted hemipenis coiled; TL/LOA: tail length/total length; TL/ TW: tail length/tail diameter; L/W: total length/mid-body diameter; RW/ HW: mid-rostral width/ interocular head width. For skull anatomy three specimens were examined (FTHM019700-02), the skull abbreviations were: P: parietal; F: frontal; N: nasal; SO: Supraoccipital; EO: Exoccipital; PO: Prootic; PM: Premaxilla; SM: Septomaxilla.


**Figure 1.** Distribution map of *X. luristanicus* sp. n. in western Iran (Badavar region, Nourabad, Lorestan Province)

***Xerotyphlops luristanicus* sp.n.**
**Holotype** (Fig. 2)
Adult male, MNHN-RA 2016.0040 (former FTHM 19710), collected by Farhang Torki on 29 March 2016, 1,750-2,100 m a.s.l., on the western slope of the central Zagros Mountains, Badavar region, Nourabad, Lorestan Province, western Iran, 34º07´ N, 47º53´ E.

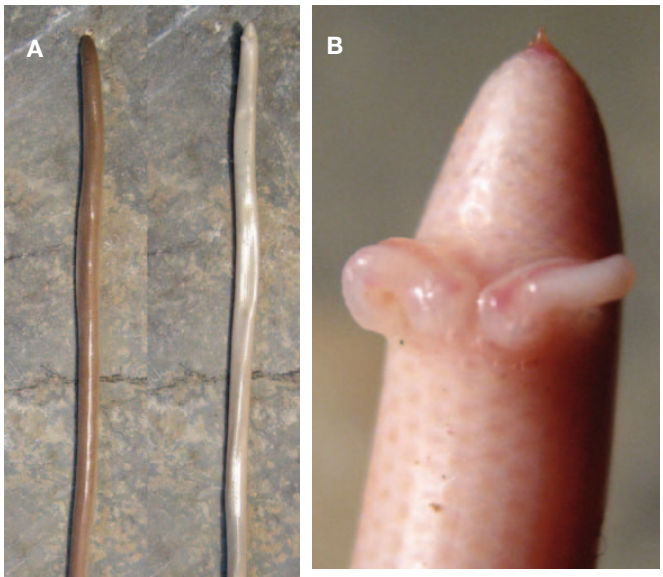


**Figure 2. (A)** dorsum (left) and venter (right) of the holotype (MNHN-RA 2016.0040) of *X. luristanicus* sp. n. **(B)** everted hemipenes of live holotype

**Paratypes**
Five specimens: MNHN-RA 2016.0041-45 (respectively former FTHM 19711-15); 2 adult males: MNHN-RA 2016.0042 and 2016.0045 (respectively former FTHM 19712, 19715); 3 adult females: MNHN-RA 2016.0041, 2016.0043-44 (respectively former FTHM 19711, 13-14), collected by Farhang Torki on 18 May 2016; same data as for holotype.

**Diagnosis**
A stout-bodied blind snake, small body size (maximum: 219 mm), moderate body form, short tail, rostral moderate. *X. luristanicus* sp. n. can easily be distinguished from all other *Xerotyphlops* species by the combination of the following characters: right side hemipenis in a single coil, left side curved, not straight; segmented testis; 22-24 longitudinal scales rows; scale reduction present or not; 355-398 transverse scale rows at mid-body; 10-12 subcaudals; supralabial imbrication pattern T-III; parietal is apparently fused as there is no suture in the middle of this bone on the external side, on the internal side a groove is observed in this place; exoccipital is completely separated from supraoccipital; the dorsal body has strong uniform pigmentation throughout while in contrast all ventral scales lack pigmentation.

**Description of holotype**
Measurements (in mm): total length: 216; tail length: 5.01; mid-body diameter: 4.90; mid-tail diameter: 3.38; transverse scale rows at mid-body: 355; scale rows round the body: at proximal: 22, at mid-body 22, at distal 22.

Body more or less cylindrical; small tail; upper head flattened and smaller than anterior body (95%), but not distinct from neck; eye diameter 0.31mm, eyes dorsolateral, not visible in ventral view, clearly visible in dorsal view, only located on upper ocular scale. Rostral long, oval and surrounded by nasals (left + right), posteriorly in contact with prefrontal, width 1.2mm, one third the head breadth, tip broadly round. Four supralabials, first is smaller than 2nd, and 2nd smaller than 3rd, and 4th is much larger than 3rd; three infralabials (IL), 1st IL larger than mental, one scale (larger than mental) between first IL, 3rd IL larger than 2nd IL. Ocular acute contacts 3rd and 4th supralabials; preocular in contact with 3rd supralabials. Prefrontal in contact with rostral and between nasals, prefrontal smaller than supraoculars (approximately 0.5x), width and length of prefrontal equal; frontal larger than prefrontal; parietal much wider than frontal; interparietal wider than frontal; parietal slightly wider than interparietal. Nostril anterolateral, oblique crescent-like slit, the nostril opening approximately same size as the eye, much nearer the tip of snout than eye, nasals not in contact and slightly distinct from rostral and prefrontal; anterior nasal in contact with 1st and 2nd supralabials; posterior nasal in contact with 2nd supralabial; inferior nasal suture in contact with 2nd supralabial. Twenty two scales around mid-body, 6 scales on dorsum, 14 on ventral and 2 lateral, dorsal scales strongly pigmented, in contrast, ventral scales are without any pigmentation, dorsolateral scales semi-pigmented; all ventral and dorsal body scales imbricate, dorsal scales uniform, ventral scales are uniform, dorsal scales smaller than ventral scales. Subcaudals mostly homogenous, one or two scales proximal and distal to subcaudals are smaller than mid-part; dorsal scales of subcaudal homogenous, last scales near spine are smaller. The testes are elongated, right is much longer and is composed of nine testicular units, it is placed more anteriorly than the left, which is composed of 10 units; right hemipen1s coiled (one coil when everted), everted left hemipenis curved (not striated and not completely coiled).

Scale pigmentation of dorsal body (including head, dorsum, caudal, ventral of subcaudal) is similar being dark brownish; venter (including head, body, cloacal and subcaudals) is whitish; spine color is same as dorsal body.

**Variation and Dimorphism**
All specimens have similar colour pattern. All specimens have supralabial imbrication pattern T-III, inferior nasal suture in contact with 2nd supralabials, and 2 postoculars. All male specimens have hemipenes similar to holotype (right is coiled and left is curved). See Table 1 for variation in measurements, scale counts, and various ratios.

All male specimens of *X. luristanicus* sp. n. have 22 longitudinal scales rows without scale reduction from anterior to posterior of body, this is true for one female (MNHN-RA 2016.0044) and is in contrast to two other females (Table 1). The mean number of transverse scales rows for females is greater than that for males (384 vs. 366). Males have longer tails than females (4.9 vs. 3.9) while females have wider tails (males: 3.29 vs. females: 3.45), the TL/TW ratio for males is greater than for females (1.5 vs. 1.1).

**Comparison with other species**
*Xerotyphlops* includes four species and can be diagnosed by several combinations of characters described by Pyron and

**Table 1.** Morphological characters for holotype and paratype specimens of *X. luristanicus* sp. n. (for abbreviations see Material and Methods)

| MNHN - RA code | Sex | LSRab | LSRmb | LSRpb | TSR | SC | LOA | W | TL | TW | RW | HW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016.0040 | M | 22 | 22 | 22 | 355 | 12 | 216 | 4.9 | 5.01 | 3.38 | 1.20 | 3.58 |
| 2016.0041 | F | 24 | 24 | 23 | 398 | 12 | 219 | 4.26 | 3.07 | 3.38 | 1.10 | 3.16 |
| **2016.0042** | M | 22 | 22 | 22 | 366 | 11 | 186 | 4.06 | 4.89 | 2.99 | 1.22 | 3.04 |
| 2016.0043 | F | 24 | 23 | 22 | 388 | 11 | 203 | 4.89 | 3.88 | 3.29 | 1.32 | 3.34 |
| 2016.0044 | F | 22 | 22 | 22 | 368 | 12 | 198 | 4.74 | 4.80 | 3.68 | 1.26 | 3.13 |
| 2016.0045 | M | 22 | 22 | 22 | 377 | 12 | 198 | 4.25 | 4.81 | 3.51 | 1.14 | 2.97 |

Wallach (2014). *X. luristanicus* sp. n. has all the combined characters; it is clearly a new species of *Xerotyphlops*. Comparisons of *X. luristanicus* sp. n. with the published descriptions of other species (Wall, 1908; Wallach, 2009; Afroosheh et al., 2012; Hedges et al., 2014; Pyron and Wallach, 2014) are as follows.

Easily distinguishable from *X. etheridgei* by everted hemipenes (coiled vs. straight), scale reduction present (yes and no vs. only yes), TSR (355-398 vs. 424), TL/LOA (1.4-2.43 vs. 1.1), L/W (41-46 vs. 55).

Easily distinguished from *X. socotranus* by low longitudinal scale rows (22-24 vs. 26-30), SIP (T-III vs. T-V), scale reduction present (yes and no vs. only yes), TL/LOA (1.4-2.43 vs. 3.1).

Easily differentiated from *X. wilsoni* by ocular in contact with labials (vs. separated from labials by the subocular), small body size (total length: 186-219 vs. 338-345) as well as slender body size (L/W: 41-46 VS. 38), scale reduction present (yes and no vs. only yes).

Distinguished from *X. vermicularis* by coiled everted hemipenis (vs. straight).

Other slight differences between *X. luristanicus* sp. n. and *X. vermicularis* are as follows: subcaudals (11-12 vs. 7-13); TL/TW is different between studies (see Table 2 and 3) as follows: mean of TL/TW is greater for *X. luristanicus* sp. n. than *X. vermicularis* (1.31 vs. 1.18) and range of *X. luristanicus* sp. n. is close to *X. vermicularis* (Afroosheh et al., 2012), in contrast *X. luristanicus* sp. n. has greater variation in TL/TW than *X. vermicularis* (0.91-1.63 vs. 1.3-1.5) (Pyron and Wallach, 2014); mean of TL/LOA in *X. luristanicus* sp. n. is greater than *X. vermicularis* (0.02 vs. 0.01) (Afroosheh et al., 2012), or is slightly different (1.4-2.43 vs. 1.8-2.5) (Pyron and Wallach, 2014). More comparisons between *X. luristanicus* sp. n. and other *Xerotyphlops* as well *X. vermicularis* are shown in Tables 2 and 3.

There are several morphological differences between *X. luristanicus* sp. n and *Indotyphlops braminus* (Daudin, 1803), which also inhabits Iran. In particular, *X. luristanicus* sp. n. has segmented testes (vs. unsegmented); the inferior nasal suture is in contact with 2nd supralabial (vs. preocular); LSR (22-24 vs. 20); SRR (both vs. neither); postocular (2 vs. 1); and, coloration of submental, tip of the tail and cloacal region in *X. luristanicus* sp. n. is white not yellowish (Wallach, 2009; Afroosheh et al., 2010; Pyron and Wallach, 2014).

Some differences between the skull bones of *X. luristanicus* sp. n., *X. vermicularis* and *I. braminus* were identified. In general, nasal, supraoccipital, and occipital

**Figure 3.** Habitat of *X. luristanicus* sp. n. at type locality, Badavar, Nourabad, Lorestan, Iran

**Table 2.** Comparison between *X. luristanicus* sp. n. with *X. vermicularis* inhabitant Iran (data from Afroosheh et al., 2012); (for abbreviations see Materials and Methods)

| Characters | *X. vermicularis* | | | *X. luristanicus* sp. n. | | |
|---|---|---|---|---|---|---|
| | Min | Max | Mean | Min | Max | Mean |
| LSRab | 22 | 24 | 23.2 | 22 | 24 | 22.6 |
| **LSRmb** | 21 | 24 | 22.8 | 22 | 24 | 22.5 |
| LSRpb | 20 | 24 | 21.7 | 22 | 23 | 22.1 |
| TSR | 340 | 438 | 389 | 355 | 398 | 375 |
| SC | 7 | 12 | 9.01 | 11 | 12 | 11.6 |
| LOA | 90 | 277 | 178 | 186 | 219 | 203 |
| W | 1.76 | 7.22 | 3.69 | 4.06 | 4.9 | 4.51 |
| **TL** | 0.60 | 5.75 | 3.01 | 3.07 | 5.01 | 4.41 |
| TW | 0.83 | 5.21 | 2.67 | 2.99 | 3.68 | 3.37 |
| RW | 0.78 | 1.79 | 1.14 | 1.1 | 1.32 | 1.2 |
| HW | 1.73 | 4.13 | 2.73 | 2.97 | 3.58 | 3.2 |
| TL/LOA | 0.01 | 0.03 | 0.01 | 0.01 | 0.02 | 0.02 |
| LOA/W | 32.7 | 85.1 | 49.4 | 41.5 | 51.4 | 45.2 |
| TL/TW | 0.5 | 2.15 | 1.18 | 0.91 | 1.63 | 1.31 |
| RW/HW | 0.27 | 0.57 | 0.42 | 0.33 | 0.4 | 0.37 |

are paired. The parietal is apparently fused as there is no suture in the middle of this bone on the external side. On the internal side a groove is observed in this place. This character is in contrast to what seen in the parietal of *X. vermicularis*, where it is single or quite unique and without groove, and in *I. braminus* it is paired or partially divided (Mookerjee and Das, 1932). According to fossil evidence the character of paired parietals is usually considered to be more primitive than the single fused homologue (List, 1966).

**Table 3.** Comparison of important characters among all species of *Xerotyphlops* (Pyron and Wallach, 2014) with *X. luristanicus* sp. n., (for abbreviations see Materials and Methods)

| | *X. etheridgei* | *X. socotranus* | *X. wilsoni* | *X. vermicularis* | *X. luristanicus* |
|---|---|---|---|---|---|
| LSR | 24 | 26-30 | 24 | 20-24 | 22-24 |
| SRR | yes | yes | yes | both | both |
| TSR | 424 | 370-435 | - | 346-410 | 355-398 |
| SC | 10 | - | - | 7-13 | 11-12 |
| TL/LOA | 1.1 | 3.1 | - | 1.8-2.5 | 1.4-2.43 |
| LOA | 220 | 200-255 | 338-345 | 92-405 | 186-219 |
| TL/ TW | 1 | 1 | | 1.3-1.5 | 0.91-1.63 |
| SIP | III | V | - | III | III |
| LOA/W | 55 | 37-50 | 38 | 34-56 | 41-51 |
| INS | 2 | 2 | 2 | 2 | 2 |
| PO | 2 | 2-3 | - | 2 | 2 |
| RW/ HW | 0.41 | 0.30-0.35 | | 0.27-0.41 | 0.33-0.40 |
| HP | S | - | - | S | C (left) |
| HPC | - | - | - | - | 1 (right) |

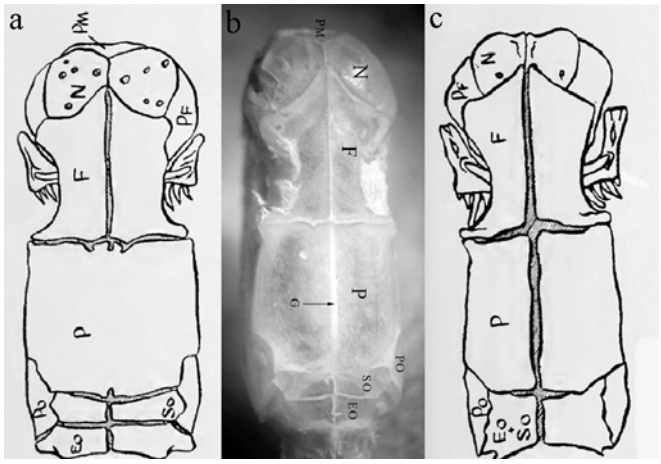


**Figure 4.** Skull comparison of (**a**) *X. vermicularis* CNHM 28572 - Chicago Natural History Museum; specimens from Benyaminia, Israel; (**b**) *X. luristanicus* sp. n. (**c**) *I. barminus* JCL 1022 - James C. List, private collection, specimens taken from Dadanduwa, Ceylon (for abbreviations see Material and Methods)

In *X. luristanicus* sp. n. this character shows an intermediate state since there is a groove in the mid-line of interior surface of the parietal. Moreover, in *I. braminus* the exoccipital is fused with supraoccipital (List, 1966), but in *X. vermicularis* and *X. luristanicus* sp. n. they are separate and paired. Also, in *I. braminus* the exoccipitals meet with each other behind the former (List, 1966), this contrasts with what is observed in *X. luristanicus* sp. n. and *X. vermicularis*.

According to List (1966) the type locality of *X. vermicularis* is near the Mediterranean Sea (Benyaminia, Israel) which is close to Clade A of Kornilios et al. (2012) (which includes Syria and Jordan populations). Clade A shows a strong genetic divergence from other clades of *X. vermicularis*, and colonisation for this population occurred about 9.8 Mya. There appear to be no significant morphological differences between Clade A and other clades, but the current study indicates some skull differences (especially in the parietal) between the Benyaminia and Lorestan populations (Fig. 4).

**Distribution**

*X. luristanicus* sp. n. is at present known only from the type locality, Badavar region, Nourabad, Lorestan Province, western Zagros Mountains, western Iran.

**Etymology**

"*luristanicus*" refers to Lorestan province (habitat of new species), "Lorestan Blind Snake" or "Laki Blind Snake" would be appropriate as common names for the new species.

**Habitat and ecology**

The type locality is the valley of the Badavar River which is surrounded by mountains (Fig. 3). *X. luristanicus* sp. n. was found beneath stones from both the base and top of Chghasalman Mountain (1,750-2,100m a.s.l.). The new species is syntopic with the following reptiles: *Natrix tessellata*, *Platyceps najadum*, *Laudakia nupta*, *Ophisops elegans*, and *Trachylepis aurata*. Important threats to the new species (as well as other animals and vegetation) are as follows: (i) waste disposal, the area is a trash dump for Nourabad city and urban rubbish is deposited near the Badavar River; (ii) agrichemicals, much of the type locality is used by farmers and gardeners; (iii) burning of postharvest residues around mid-summer; and (iv) recreation, the area is used by city dwellers mainly at weekends.

## DISCUSSION

The present study shows that the external morphology of *X. luristanicus* sp. n. is similar to that of *X. vermicularis* (e.g., Wall, 1908; Wallach, 2009; Afroosheh et al., 2012, 2013; Pyron and Wallach, 2014), although there is a distinct difference in hemipenal morphology. The genetically distinct populations and wide distribution of *X. vermicularis* among completely different ecological and climatically areas from northern Africa, southern Europe towards the Middle East, indicate that *X. vermicularis* is a complex taxon and the current study suggests that *X. luristanicus* sp. n. is a cryptic species, close to the *X. vermicularis*-complex.

A genetic study of *X. vermicularis* inhabiting Iran shows the species split into two clades (Kornilios et al., 2012): clade E, that includes a population from Kermanshah (near

type locality of *X. luristanicus* sp. n.), and clade I in other areas including northeastern, southern and southwestern Iran. Based on geological maps, the type locality of *X. luristanicus* sp. n. is close to a population of *X. vermicularis* from Ravansar and Kermanshah (e.g., Wrobel-Daveau et al., 2010; Verges et al., 2011). Therefore, it is suggested that *X. luristanicus* sp. n. is close to clade E of Kornilios et al. (2012). Although statistical tests of taxonomical characters do not show differences between Iranian populations (including clade I and E), phylogenetic data indicate differences between the two clades; clade E diverged from clade I in 3.3 Mya (Kornilios et al., 2012). The western Zagros Mountains are considered as "hot spots" for reptile diversity. Owing to the geological history of these mountains there is an unusual number of narrowly endemic species in this region, many of which have been described only within the last two decades.

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