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Previous volumes (2010-2020): 250 € / year (4 issues)

Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d'avenir » programme (Labex Agro: ANR-10-LABX-0001-01)



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## A NEW SPECIES OF *NEOSCIRULA* (ACARI: CUNAXIDAE: COLEOSCIRINAE) FROM THE OZARK HIGHLANDS (USA), WITH A NOTE ON BIOGEOGRAPHY

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(Received 15 October 2010; accepted 19 May 2011; published online 23 September 2011)

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**ABSTRACT** — A new species of the family Cunaxidae, *Neoscirula reticulata* Skvarla **n. sp.**, is described from two locations in the Ozark Highlands of North America. The importance of biodiversity research in this understudied region is discussed, as well as the biogeographic connection between the Interior Highlands and highlands of Mexico in relation to this species. Also, in concordance with recent advances in taxonomic procedures, both *N. reticulata* and all other described species of *Neoscirula* have been registered with Zoobank. A comprehensive list of these species, incorporating citations of their original description and Zoobank LSID numbers, is provided to aid future researchers. Images were created using digital illustration techniques designed to speed-up the description process and were subsequently deposited into Morphbank. Finally, an updated key to the adults of world species is included.

**KEYWORDS** — Acari; Cunaxidae; Taxonomy; Ozark; digital illustration; key

**LSID NUMBER** — urn:lsid:zoobank.org:pub:EE092893-8AFC-4100-AD2B-B0BC0886B823

### INTRODUCTION

Cunaxidae are predatory mites found in soil/litter, vegetation, vertebrate nests, agricultural settings, and stored products (Den Heyer 1977; Ferla and Moraes 1998; Grout and Ueckermann 1999; Gupta and Chattopadhyay 1978; Hughes 1976). These mites are well known for their raptorial, spine-equipped palpi (except in the subfamily Bonziinae) that are used to grasp prey (Krantz and Walter 2009). Unlike Cunaxinae, which ambush passing prey with their long spiny palpi, Coleoscirinae (including *Neoscirula*) and Cunaxoidinae are active predators with shorter, less adorned palpi that

search out less active prey, including nematodes (Den Heyer 1981; Krantz and Walter 2009; Walter, Hunt, and Elliot 1988; Walter and Kaplan 1991).

Twenty-five *Neoscirula* Den Heyer, 1977 are known worldwide. Only one species has been described from North America north of Mexico, *N. kenworthyi* Smiley, 1992, which is known only from the type locality in Maryland, USA.

This study marks the first *Neoscirula* recorded from the Ozark Highlands. The Ozark Highlands are a proposed area of hyperdiversity, comprising some of the oldest continuously exposed land worldwide. As a result, the Ozark Highlands have

potentially served as refugia for species displaced by glaciation or flooding events throughout biological history (The Nature Conservancy, Ozarks Ecoregional Assessment Team 2003). Although many species found in the Ozarks are typical of mid-western North America, many are more characteristic of other continuously exposed refugia such as the southern Appalachian Mountains and Sierra Madre in Mexico. Furthermore, the Interior Highlands (including the Ozarks) is a proposed area of high endemism, with over 200 known endemics (Allen 1990; Redfearn 1986). Nevertheless, in comparison to other regions of suspected hyperdiversity, the region remains grossly understudied with unsettlingly few active researchers investigating basic questions about biogeography and species composition, especially with regard to arthropods (but see Moulton and Stewart 1996 [caddisflies], and Poulton and Stewart 1991 [stoneflies]).

The present work represents another stepping-stone toward resolving this issue, and brings mites, a group well known for being both diverse and underrepresented, into the forefront of Interior Highland biogeographic and biodiversity research.

## MATERIALS AND METHODS

Leaf litter samples were collected at two sites in the Ozark Highlands: Steel Creek in the Buffalo National River (Arkansas) and Hercules Glades Wilderness in the Ava-Cassville-Willow Springs ranger district of Mark Twain National Forest (Missouri). Both sites are Eastern mixed deciduous forest dominated by oak (*Quercus*) and hickory (*Carya*), although eastern red cedar (*Juniperus virginiana* L.) was also abundant at the Buffalo National River site. All samples were processed for three to seven days using modified Berlese-Tullgren funnels.

All specimens are mounted in Hoyer's medium. The holotype and three paratypes are deposited in the Acarology Collection at the University of Arkansas (ACUA). One paratype is deposited in the United States National Museum (USNM) and an-

other paratype is deposited in the Ohio State University Acarology Collection (OSAL).

In accordance with recent efforts to make taxonomic information more attainable, both *Neoscirula reticulata* and all other known *Neoscirula* have been registered with ZooBank (<http://www.zoobank.org/>). A list of LSID numbers and descriptions is given with corresponding species in Table 1.

All line drawings were created digitally from montaged compound micrographs using the vector-based Adobe Illustrator CS5 and a Wacom Cintiq 21UX with touch sensitive, draw-on-screen capability. This process, described by Fisher and Dowling (2010), is designed to greatly speed the drawing process by eliminating paper steps. Line drawings have been submitted to MorphBank (<http://www.morphbank.net>).

All measurements are from type specimens and given in micrometers ( $\mu\text{m}$ ). Body length is measured from the posterior limit of the idiosoma to the anterior edge of the propodosomal shield. Leg length is measured from the proximal edge of the trochanter to the distal end of the claw. Lengths are reported as the range recorded followed parenthetically by the median.

The setal notation follows Kethley (1990) as it has been applied to cunaxids by Swift (1996) and Den Heyer and Castro (2008a). The following abbreviations are used: attenuate solenidion (ats), bulbous solenidion (bbsl), blunt rod-like solenidion (bsl), dorsodistal solenidion (dtsl), famulus (fam) (=peg organ), microseta (mst), paracoxal simple tactile seta (pcs), spine-like seta (spl), simple tactile seta (sts), terminal solenidion (tsl), trichobothrium (T) (Fig. 1).

### *Neoscirula* Den Heyer, 1977

Den Heyer (1977) erected *Neoscirula* to accommodate three African cunaxids. The genus was subsequently placed into Coleosirinae (Den Heyer 1981). Smiley (1992) moved *Neoscirula* to Bonziinae based on seta *hg1* being geniculate. Den Heyer and Castro (2008b) moved the genus back to Coleosirinae,

TABLE 1: Known species of *Neoscirula*, associated descriptions, and ZooBank LSID numbers.

Species	Citation	LSID
<i>N. abraensis</i>	Corpuz-Raros, 1996	urn:lsid:zoobank.org:act:CA19B721-ADCA-435B-88F6-A2CDB69AA3BE
<i>N. aliciae</i>	Mejía-Recamier & Palacios-Vargas, 2007	urn:lsid:zoobank.org:act:E5176502-35E9-4C68-8E8B-A00B859871BA
<i>N. aspirasi</i>	Corpuz-Raros, 1996	urn:lsid:zoobank.org:act:5833ED0A-7B36-4BE3-A3CB-10ADE507B322
<i>N. baloghi</i>	Mejía-Recamier & Palacios-Vargas, 2007	urn:lsid:zoobank.org:act:9CA2400E-15E8-4DD6-98AF-CABECA42A327
<i>N. bidens</i>	Lin & Zhang, 1998	urn:lsid:zoobank.org:act:26B17771-20F0-4902-A938-8947DE641FEF
<i>N. delareyi</i>	Den Heyer, 1980	urn:lsid:zoobank.org:act:941E8F8C-A953-495F-96F9-3ACB07D58B3A
<i>N. flechtmanni</i>	Den Heyer & Castro, 2008	urn:lsid:zoobank.org:act:2DE430BC-7B08-4C5B-B222-CBAF400EF16B
<i>N. hoffmannae</i>	Mejía-Recamier & Palacios-Vargas, 2007	urn:lsid:zoobank.org:act:C1CC44D5-F674-4431-B950-B3770CC1A6BD
<i>N. imperata</i>	Corpuz-Raros, 1996	urn:lsid:zoobank.org:act:D572DA60-1F0A-4CB1-B66B-DBE911085AD7
<i>N. kenworthyi</i>	Smiley, 1992	urn:lsid:zoobank.org:act:9FA8701B-932C-48A1-B692-82438AD8A907
<i>N. laboensis</i>	Corpuz-Raros, 2007	urn:lsid:zoobank.org:act:E443DB9B-E94D-4CA5-A325-A3FF98EC4659
<i>N. luxtoni</i>	Smiley, 1992	urn:lsid:zoobank.org:act:77B5021F-6FEF-4C2A-849E-AD330D4DDC1D
<i>N. makilingica</i>	Corpuz-Raros, 1996	urn:lsid:zoobank.org:act:54398742-257C-4C7A-B8B6-B57C1A5B2CCD
<i>N. miaofengensis</i>	Lin & Zhang, 1998	urn:lsid:zoobank.org:act:C89AEA71-74A5-4E1F-9352-83946AB2C64F
<i>N. natalensis</i>	Den Heyer, 1977	urn:lsid:zoobank.org:act:ED1DC4C2-6EC3-4356-B336-6EAFA5DC8B1
<i>N. oliveirai</i>	Den Heyer & Castro, 2008	urn:lsid:zoobank.org:act:27DAD48D-F2D9-4177-AA38-1BFB2F451077
<i>N. ogawai</i>	(Shiba, 1978)	urn:lsid:zoobank.org:act:3F82DDB0-6187-4703-9930-906264789E8B
<i>N. proctorae</i>	Smiley, 1992	urn:lsid:zoobank.org:act:33AA52C3-FFE8-4DF3-85A3-84BF2629E8F7
<i>N. putinglupa</i>	Corpuz-Raros, 1996	urn:lsid:zoobank.org:act:23230DF9-78C5-4B6E-9262-8C971230FF74
<i>N. queirozi</i>	Den Heyer & Castro, 2008	urn:lsid:zoobank.org:act:4944330E-6657-4B4F-BB96-D6AC3C96776B
<i>N. reticulata</i>	Skvarla et. al. 2011	urn:lsid:zoobank.org:act:46F9917D-C4D3-4346-9DD5-840D077C072C
<i>N. saitoi</i>	Lin, in Lin & Zhang, 2002	urn:lsid:zoobank.org:act:D0B29B4C-6EB3-4E7D-9E41-937B05AEF3C8
<i>N. sevidi</i>	Den Heyer, 1977	urn:lsid:zoobank.org:act:DA7B4D20-0452-4C90-B267-A0E20AEA9E1F
<i>N. taclobanensis</i>	Corpuz-Raros, 2007	urn:lsid:zoobank.org:act:663B9B27-53B8-4F42-A9EC-5DF8326CAF8C
<i>N. theroni</i>	Den Heyer, 1977	urn:lsid:zoobank.org:act:975048D4-3D0B-4844-AAF6-C476F3D34B19
<i>N. vitulus</i>	Barilo, 1991	urn:lsid:zoobank.org:act:2D015EBB-E4DB-4539-870F-6E4CF9CE4D4F

saying that *hg1* is only bent and not truly geniculate. The authors agree with Den Heyer and Castro that *Neoscirula* should be placed in Coleoscirinae.

The palpi of *Neoscirula* are five-segmented and end in a strong claw, which is complemented with a tooth in some species; they extend to the tip of the hypognathum or slightly beyond. The palp tibio-tarsus is short and cone-like. Four pairs of setae are present on the hypognathum (*hg1-4*); *hg1* is longest and in some species bent at 90 degrees. Adoral setae present or absent.

A cheliceral seta is usually present near the digit, though may be absent. The propodosomal shield is weakly sclerotized and ill-defined. It is granulated or papillated; some species possess subcutic-

ular reticulations. Coxal plates I and II may be separate or fused medially into a single sternal shield. Coxal plates III and IV contiguous on either side, restricted to area around trochanteral bases. Dorsal cupules *im* present laterad to *e1*; ventral cupules *ih* present near *h2*, anal plates. All legs are shorter than body. The basifemur and telofemur are fused but retain the suture; each has a dorsolateral simple or spine-like seta. Ambulacral claws are smooth.

#### *Neoscirula reticulata* Skvarla sp. nov.

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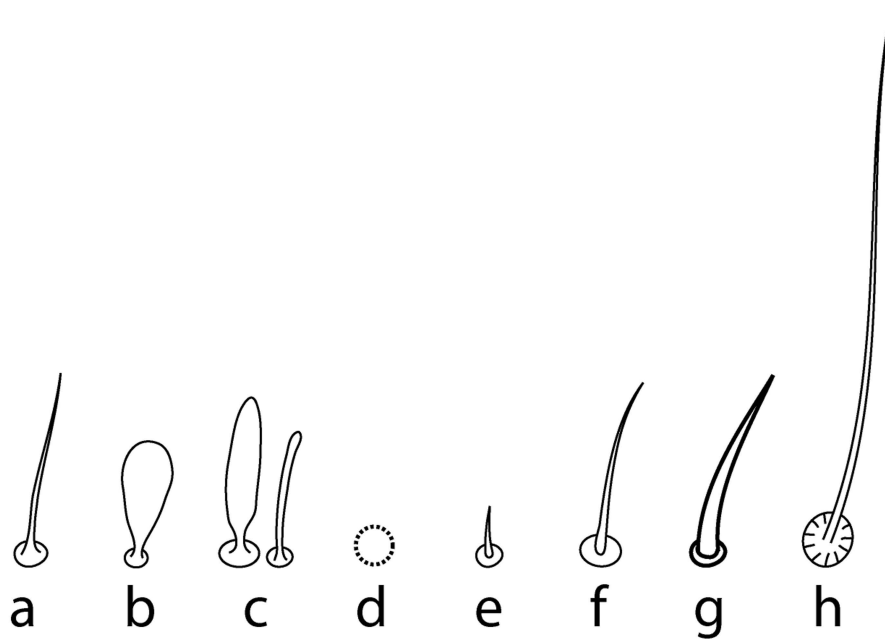


FIGURE 1: Examples of the different types of setae referred to in the text by abbreviations. a – Attenuate solenidion (ats). b – Bulbous solenidion (bbsl). c – Two types of blunt rod-like solenidion (bsl). d – Famulus (fam)(=peg organ). e – Microseta (mst). f – Simple tactile seta. g – Spine-like seta (spl). h – Trichobothrium (T).

### Diagnosis

*Neoscirula reticulata* Skvarla **sp. nov.** and *N. baloghi* Mejía-Recamier and Palacios-Vargas, 2007 can be distinguished from all other *Neoscirula* by a lack of a cheliceral seta and medially fused coxal plates I and II. *N. reticulata* can be distinguished from *N. baloghi* by the presence of reticulations on the chelicerae, as well as differences in leg setal complements as follows: genua II, 2 ats-5 sts; genua IV, 1 ats-5 sts.

### Female

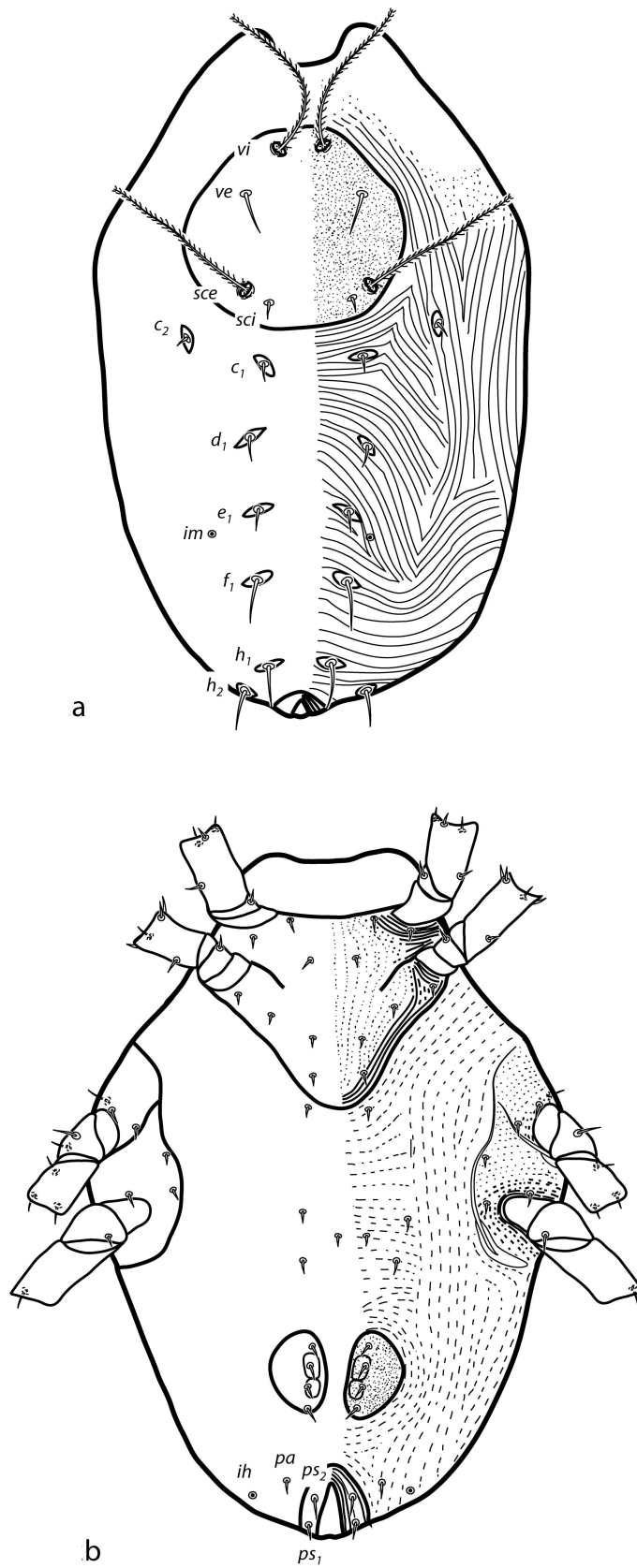
Idiosoma — 265 – 338 (307, n=6) long, 195 – 238 wide (213).

Dorsum — (Fig. 2a). Single oval propodosomal shield; finely granulated, lacking subcuticular reticulation. Two setose sensilla, *vi* and *sce*, on shield; 95 and 82, respectively. Two setae, *ve* and *sci*, also on shield, 21 and 9, respectively. Seven pairs of dorsal hysterosomal setae present; all occur on sclerotized, granulated plates. Setae *c*<sub>1</sub>, *c*<sub>2</sub>, *d*<sub>1</sub>, *e*<sub>1</sub>, and *h*<sub>2</sub> approximately equal in length (15, 12, 14, 16, 17); *f*<sub>1</sub> and *h*<sub>1</sub>

longer (21, 24). *f*<sub>2</sub> absent. Cupule *im* present, laterad to *e*<sub>1</sub>. Integument between setae striated.

Venter — (Fig. 2b). Coxal plates I and II well sclerotized, fine subcuticular granulation forming striations. Plates fused medially into a sternal shield with narrowly rounded posterior limit. Sternal shield bearing with 7 pairs of sts, sometimes capturing an extra pair of setae between coxae III. Coxal plates III and IV also well sclerotized and finely granulated. Coxae III with 3 sts, one of which may appear dorsal; coxae IV with 2 sts and 1 pcs. 3 pairs of setae on integument between coxae IV (not including pair sometimes captured by sternal shield). Granulae on integument form striations around coxae. Genital plates weakly sclerotized with 4 pairs of setae and 2 pairs of underlying genital papillae. Anal plates bearing 2 pairs of pseudanal setae (*ps*<sub>1</sub> and *ps*<sub>2</sub>). Cupule *ih* present laterad to para-anal setae (*pa*).

Gnathosoma — (Fig. 3). *Hypognathum* (Fig. 3a) small, less than ¼ length of idiosoma, 69 – 73 (71). Four pairs of setae (*hg*<sub>1-4</sub>): *hg*<sub>1</sub> is bent and nearly



75

FIGURE 2: *Neoscirula reticulata*, **sp. nov.**, female idiosoma. a – Dorsum. b – Venter, including trochanters I-IV and basifemora I-IV.

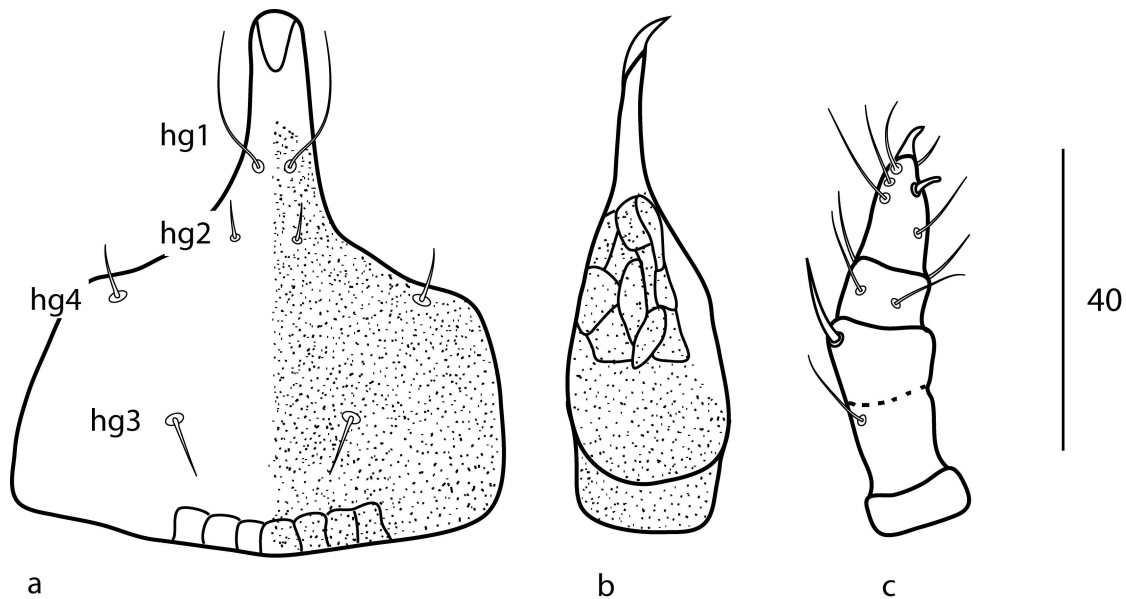


FIGURE 3: *Neoscirula reticulata*, **sp. nov.**, female gnathosoma. a – Subcapitulum. b – Chelicera, dorsal. c – Palp, dorsal.

twice as long (20) as the other three (11, 10, 9). Adoral setae absent. Single row of posterior polygonal subcuticular sculpturing present. *Chelicera* (Fig. 3b) 68 – 75 (71), thin distally with broad base; integument granulated dorsally, dorsomedially reticulate, and smooth ventrally. *Palp* (Fig. 3c) 44 – 53 (49). Setal complement: trochanter, 0; basifemur, 1 sts; telofemur, 1 spls; genu, 4 sts; tibiotarsus, 4 sts, 1 spls, 1 dtsl. The tibiotarsus ends in a stout claw which lacks a tooth.

**Legs** — (Fig. 4a-d). All shorter than idiosoma. Length: I, 125 – 155 (143); II, 118 – 138 (127); III, 135 – 155 (146); IV, 153 – 190 (165). Setal formulae: trochanters, 1-1-2-1 sts; basifemora, 4-5-3-1 sts; telofemora, 5-5-4-3 sts; genua I, 3 ats, 1mst, 4 sts; genua II, 2 ats, 5 sts; genua III, 1 ats, 5 sts; genua IV, 1 ats, 5 sts; tibiae I, 2 bls, 5 sts; tibiae II, 1 bsl, 5 sts; tibiae III, 1 bsl, 5 sts; tibiae IV, 1 T, 4 sts; tarsi I, 2 bbsl, 2 ats, 1 fam, 2 tsl, 20 sts; tarsi II, 1 bsl, 20 sts; tarsi III, 1 tsl, 19 sts; tarsi IV, 19 sts.

#### Male and immatures

Unknown.

#### Etymology

This species is named for the distinctive reticulations on the chelicerae.

#### Material examined (all on slides)

**Holotype:** female, *ex.* mixed cedar and oak litter, USA, Arkansas, Newton Co, Buffalo National River, Steel Creek (36°01.942 N, 93°20.010 W), 28 May 2010, J. R. Fisher and M. J. Skvarla, APGD 10-0528-008,001; **Paratype:** 2 females, *ex.* mixed cedar and oak litter, USA, Arkansas, Newton Co, Buffalo National River, Steel Creek (N 36°01.942 , W 93°20.010), 28 May 2010, J. R. Fisher and M. J. Skvarla, APGD 10-0528-008,002-003; 3 females, *ex.* litter, USA, Missouri, Taney Co., Mark Twain National Forest (N 36°40.017, W 92°53.367), 22 May 2010, J. R. Fisher and D. M. Keeler, APGD 10-0522-002, 001-003.

#### Remarks

*Neoscirula reticulata* Skvarla **sp. nov.**, from the North American Ozark Highlands, most resembles *N. baloghi* Mejía-Recamier and Palacios-Vargas, 2007, from Jalisco, Mexico. This biogeographic relationship between the temperate forests of eastern

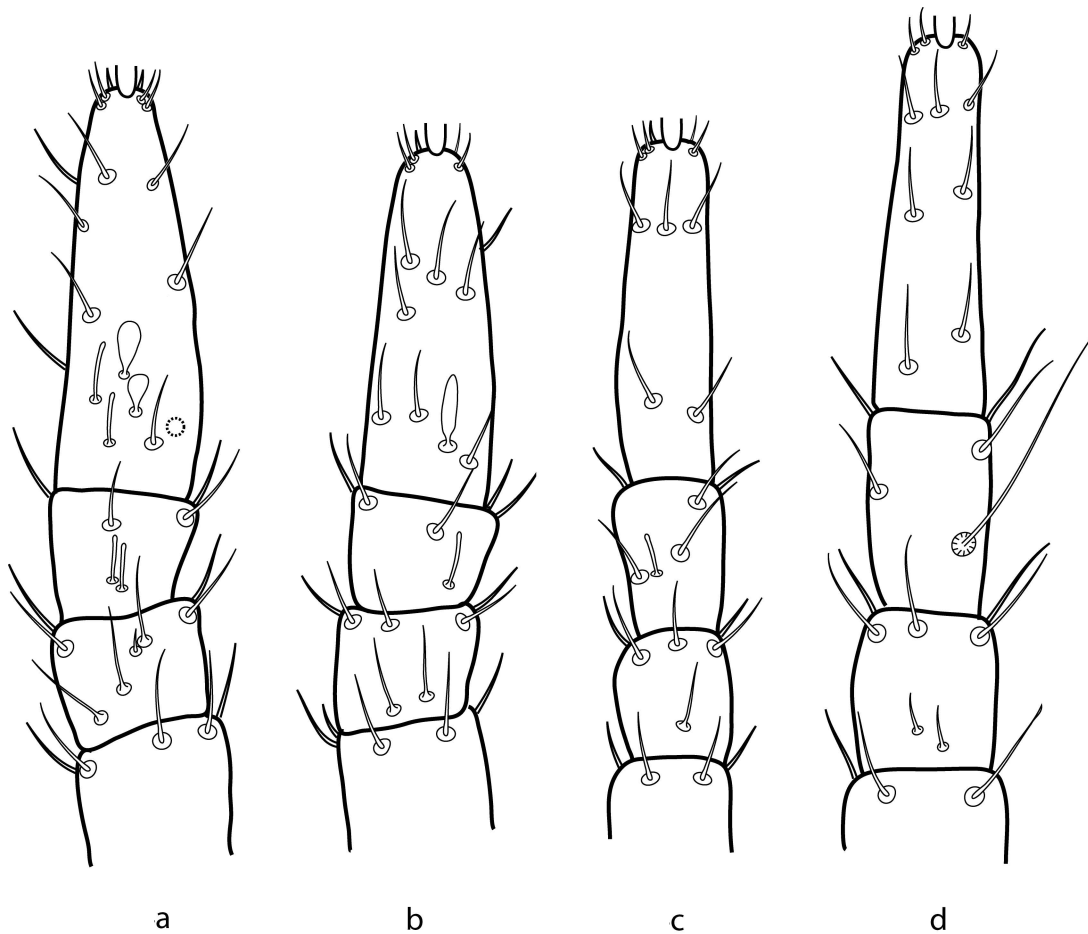


FIGURE 4: *Neoscirula reticulata*, **sp. nov.**, female legs: dorsal telofemora, genua, tibiae, and tarsi. a – Leg I. b – Leg II. c – Leg III. d – Leg IV.

North America and Mexico is not unusual. Well-known cases displaying this affinity include mosses (Crum 1952; Redfearn 1986), higher plants (Braun 1955; Dressler 1954; Miranda and Sharp 1950; Watson 1891), Fungi (Miranda and Sharp 1950, Sharp 1948), and snakes, flying squirrels and plethodontid salamanders (see Martin and Harrel 1957).

To the authors' knowledge, the present study represents the first attempt to implicate a mite, and perhaps any arthropod, as a representative of the Mexican-East North American affinity. The presumed low-dispersal capabilities and hyperdiversity of soil/litter dwelling organisms, as well as their underrepresentation in biogeographic studies, make them perfect candidates to address such questions.

#### Key to adult *Neoscirula*

This key has been updated from Mejía-Recamier and Palacios-Vargas (2007) to include *N. reticulata* **sp. nov.**, *N. vitulus* Barilo, *N. laboensis* Corpuz-Raros, *N. taclobanensis* Corpuz-Raros, *N. flechtmanni* Den Heyer and Castro, *N. oliveirai* Den Heyer and Castro, and *N. queirozi* Den Heyer and Castro, as well as known localities for all species. Unless otherwise noted, setae are simple.

- 1 Coxal plates I-II fused to form a sternal shield .. 2
- Coxal plates I-II widely separated ..... 6
- 2 Cheliceral seta present.....3
- Cheliceral seta absent ..... 5



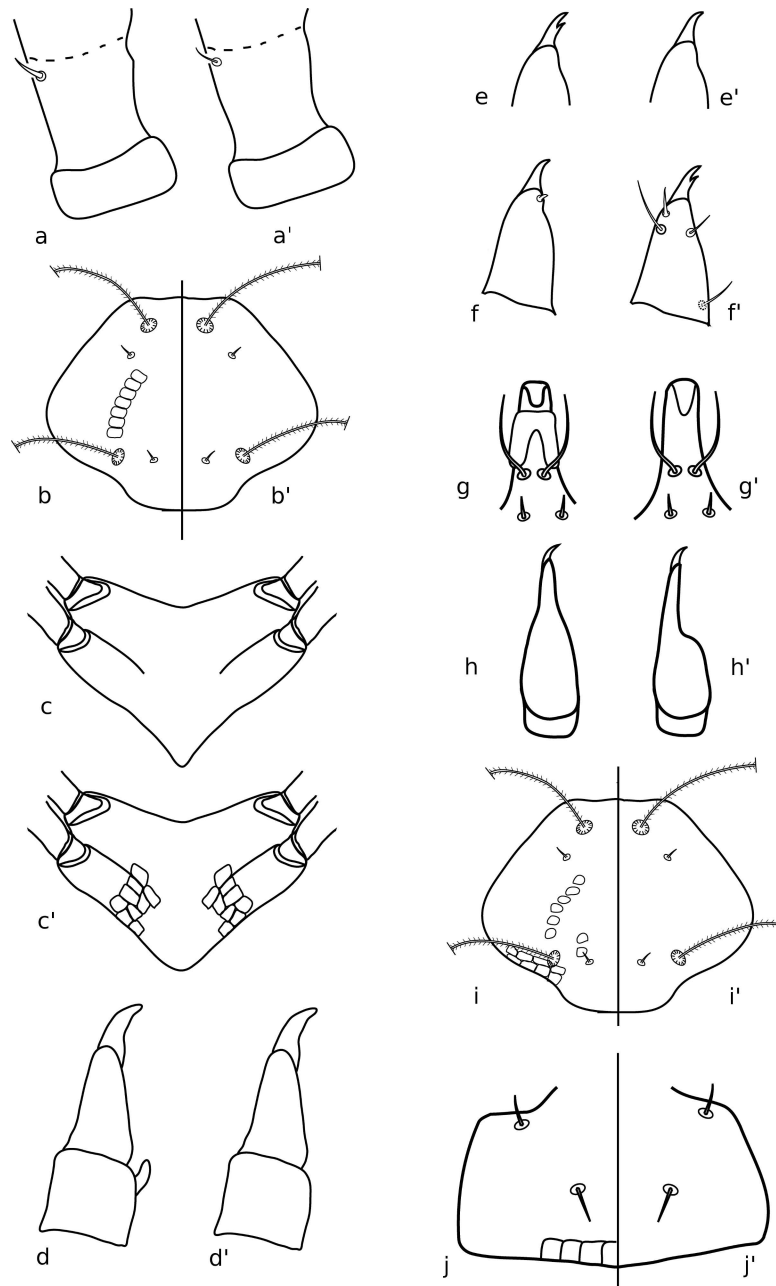


FIGURE 5: Explanatory figures for key. Illustrations of specific species are noted parenthetically. a – Palpal basifemoral seta spine-like. a' – Palpal basifemoral seta simple. b – Propodosomal shield with polygonal subcuticular sculpturing. b' – Propodosomal shield without polygonal subcuticular sculpturing. c – Posteromedial portion of sternal shield V-shaped (*N. aspirasi*). c' – Posteromedial portion of sternal shield rounded (*N. ogawai*). d – Palpal genua with hook-like apophysis (*N. natalensis*). d' – Palpal genua without hook-like apophysis. e – Palpal tibiotarsal claw with tooth, appearing bifid. e' – Palpal tibiotarsal claw without tooth. f – Palpal tibiotarsi with tubercle (setae removed to highlight tubercle). f' – Palpal tibiotarsi without tubercle (*N. oliveirai*). g – Hypognathum with ventro-apical shield-like process (*N. luxtoni*). g' – Hypognathum without ventro-apical shield-like process. h – Chelicerae tapering to digit gradually (*N. bidens*). h' – Chelicerae tapering to digit suddenly (*N. flechtmanni*). i – Propodosomal shield with polygonal subcuticular sculpturing (*N. saitoi*). i' – Propodosomal shield without polygonal subcuticular sculpturing. j – Subcapitulum with row of basal polygonal subcuticular sculpturing. j' – Subcapitulum without row of basal polygonal subcuticular sculpturing.

3 Palp basifemoral dorsal seta spine-like (Fig. 5a); Luzon Is., Philippines.....*N. makilingica*  
— Palp basifemoral dorsal seta simple (Fig. 5a') .. 4

4 Propodosomal shield with polygonal subcuticular sculpturing (Fig. 5b); posteromedial portion of sternal shield V-shaped, without polygonal sculpturing (Fig. 5c); 6 pairs of setae between coxae III-IV (excluding genital setae); Luzon Is., Philippines.....*N. aspirasi*  
— Propodosomal shield without polygonal subcuticular sculpturing (Fig. 5b'); posteromedial portion of sternal shield rounded, with polygonal sculpturing (Fig. 5c'); 4 pairs of setae between coxae III-IV (excluding genital setae); Malaysia; Philippines ....*N. ogawai*

5 Chelicerae with dorsomedial reticulations (Fig. 3b); genua II with 5 setae and 2 solenidia; genua IV with 5 setae and 1 solenidion; Interior Highlands, USA ..... *N. reticulata* **sp. nov.**  
— Chelicerae without dorsomedial reticulations; genua II with 4 setae and 2 solenidia; genua IV with 4 setae and 1 solenidion; Jalisco, Mexico. .*N. baloghi*

6 Palp genua with hook-like apophysis (Fig. 5d); South Africa ..... *N. natalensis*  
— Palp genua without hook-like apophysis (Fig. 5d') ..... 7

7 Palp tibiotarsal claw with a tooth, giving bifid appearance (Fig. 5e) ..... 8  
— Palp tibiotarsal claw without a tooth (Fig. 5e')... .. 13

8 Cheliceral seta present; palpal tibiotarsi with tubercle (Fig. 5f)..... 9  
— Cheliceral seta absent; palpal tibiotarsi without tubercle (Fig. 5f'); São Paulo, Brazil.....*N. oliveirai*

9 Basifemora II with 4 setae; telofemora I-II 4-4 setae; hypognathum with ventro-apical shield-like process (Fig. 5g); New Zealand; Philippines .....*N. luxtoni*  
— Basifemora II with 5 or 6 setae; telofemora I-II 5-5 setae; hypognathum without ventro-apical shield-like process (Fig. 5g') ..... 10

10 Basifemora II with 5 setae ..... 11  
— Basifemora II with 6 setae ..... 12

11 Basifemora I with 4 setae; telofemora III with 4 setae; 7 pairs of setae between coxae III-IV (excluding genital setae); Jalisco, Mexico ..... *N. aliciae*  
— Basifemora I with 5 setae; telofemora III with 3 setae; 5 pairs of setae between coxae III-IV (excluding genital setae); Luzon Is., Philippines .....*N. laboensis*

12 Chelicerae tapering to digit gradually (Fig. 5h); Fujian, China .....*N. bidens*  
— Chelicerae tapering to digit suddenly (Fig. 5h'); São Paulo, Brazil ..... *N. flechtmanni*

13 Palp basifemoral dorsal seta spine-like (Fig. 5a)... .. 14  
— Palp basifemoral dorsal seta simple (Fig. 5a')..... 18

14 Telofemora I-II with 4-4 setae; New Zealand ....*N. proctorae*  
— Telofemora I-II with 5-5 setae ..... 15

15 Propodosomal shield with polygonal subcuticular sculpturing (Fig. 5i); Fujian, China ..... *N. saitoi*  
— Propodosomal shield without polygonal subcuticular sculpturing (Fig. 5i') ..... 16

16 Cheliceral seta short, less than half the length of movable digit; South Africa ..... *N. sevidi*  
— Cheliceral seta long, nearly as long or longer than movable digit..... 17

17 Chelicerae basally narrow, 5-6 times longer than wide; Jalisco, Mexico ..... *N. hoffmannae*  
— Chelicera basally broad, 2-3 times longer than wide; São Paulo, Brazil.....*N. queirozi*

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## ACKNOWLEDGEMENTS

The authors thank Danielle Keeler for her assistance in collecting the specimens described in this manuscript and the U.S. National Park Service and the U.S. Forest Service for granting us access and permission to collection sites. We also thank the anonymous reviewers for their helpful comments.

## REFERENCES

- Allen R.T. 1990 — Insect endemism in the Interior Highlands of North America — *Fla. Entomol.*, 73(4): 539-569. doi:10.2307/3495270
- Barilo A.B. 1991 — Two new species Cunaxidae (Acari-formes) from Central Asia — *Zool. Zh.*, 70(9): 131-136.
- Braun E.L. 1955 — The phytogeography of unglaciated eastern United States and its interpretation — *Bot. Rev.*, 21(6): 297-375. doi:10.1007/BF02872433
- Corpuz-Raros L.A. 1996 — Philippine predatory mites of the family Cunaxidae (Acari). 5. Genera *Neoscirula* Den Heyer, *Parabonzia* Smiley and *Orangescirula* Bu and Li — *Philipp. Agric. Sci.*, 79: 15-37.
- Corpuz-Raros L.A. 2007 — Additional species of Bonziinae and Cunaxoidinae and description of the male of *Coleoscirus horidula* (Tseng) (Coleosirinae) from the Philippines (Cunaxidae, Acari) — *Asia Life Sci.*, 16(2): 153-173.
- Crum H.A. 1952 — The Appalachian-Ozarkian element in the moss flora of Mexico with a check-list of all known Mexican mosses — Ph.D. dissertation, University of Michigan. University Microfilms, Inc., Ann Arbor, Michigan.
- Den Heyer J. 1977 — A new genus *Neoscirula* (Cunaxidae: Prostigmata: Acari) from the Ethiopian region — *J. Ent. Soc. Sth. Afr.*, 40(1): 73-86.
- Den Heyer J. 1980 — Six new species of the subfamily Coleosirinae (Cunaxidae: Actinedida: Acarida) — *Phytophylactica*, 12: 105-128.
- Den Heyer J. 1981 — Systematics of the family Cunaxidae Thor, 1902 (Actinedida: Acarida) — Publication of the University of the North, series A223, 1-12.
- Den Heyer, J. Castro, T.M.M.G. 2008a — A new cunaxid genus with descriptions of two new species from Brazil (Acari: Prostigmata: Bdelloidea: Cunaxidae) — *Zootaxa*, 1731: 42-50.
- Den Heyer J., Castro T.M.M.G. 2008b — Subfamilial affiliation of *Neoscirula* (Acari: Prostigmata: Cunaxidae) and descriptions of three new species of this genus from Brazil — *Zootaxa*, 1731: 51-62.

- Dressler R.L. 1954 — Some floristic relationships between Mexico and the United States — J. N. Engl. Bot. Club, 56(665): 81-96.
- Ferla N.J., Moraes G.J. 1998 — Predaceous mites in apple orchards in Rio Grande do Sol — An. Soc. Entomol. Brasil, 27(4): 649-654. doi:10.1590/S0301-80591998000400019
- Fisher J.R., Dowling A.P.G.D. 2010 — Modern methods and technology for doing classical taxonomy — Acarologia 50(3): 395-409.
- Grout T.G., Ueckermann E.A. 1999 — Predatory mites (Acari) found under citrus trees in the Southern African Lowveld — Internat. J. Acarol., 25(3): 235-238. doi:10.1080/01647959908684158
- Gupta S.K., Chattopadhyay S. 1978 — Studies on Acari associated with bird nests in Bengal, India — Indian J. Acarol., 2: 77-86.
- Hughes A.M. 1976 — The mites of stored food and houses — Minist. Agric. Fish. Food Tech. Bull. 9.
- Kethley J. 1990 — Acarina: Prostigmata (Actinedida) — In: Dindal, D.L. (Ed). Soil Biology Guide. New York: John Wiley and Sons. pp 667-756.
- Krantz G.W., Walter D.E. 2009 — A manual of acarology, 3<sup>rd</sup> edition — Lubbock: Texas Tech University Press. pp. 807.
- Lin L-Z., Zhang Y-Z. 1998 — Three new species of the Bonziinae from Fujian (Acari: Cunaxidae) — Wuyi Sci. J., 14: 24-30.
- Lin L-Z., Zhang Y-Z. 2002 — Two new species of the Bonziinae from China (Acari: Cunaxidae) — Syst. and Appl. Acarol., 7: 143-148.
- Martin P.S., Harrell B.E. 1957 — The Pleistocene history of temperate biotas in Mexico and eastern United States — Ecology, 38(3): 469-480.
- Mejía-Recamier B.E., Palacios-Vargas J.G. 2007 — Three new species of *Neoscirula* (Prostigmata: Cunaxidae) from a Tropical dry forest in Jalisco, Mexico — Zootaxa, 1545: 17-31.
- Miranda F., Sharp A.J. 1950 — Characteristics of the vegetation in certain temperate regions of eastern Mexico — Ecology, 31: 313-333.
- Moulton S.R., Stewart K.W. 1996 — Caddisflies (Trichoptera) of the Interior Highlands of North America — Gainesville: Mem. Am. Entomol. Inst. No. 56.
- Poulton B.C., Stewart K.W. 1991 — The stoneflies of the Ozark and Ouachita Mountains (Plecoptera) — Gainesville: Mem. Am. Entomol. Inst. No. 38.
- Redfearn P.L., Jr. 1986 — Bryogeography of the Interior Highlands of North America: taxa of critical importance — The Bryologist, 89(1): 32-34. doi:10.2307/3243074
- Sharp A.J. 1948 — Some Fungi common to the highlands of Mexico and Guatemala and eastern United States — Mycologia, 40: 499-502.
- Shiba M. 1978 — Taxonomic investigation on free-living Prostigmata from the Malay Peninsula — Nat. and Life in S. E. Asia, 7: 83-229.
- Smiley R.L. 1992 — The predatory mite family Cunaxidae (Acari) of the world with a new classification — West Bloomfield, Michigan: Indira Publishing House.
- Swift, S.F. 1996 — Two new species of *Dactyloscirus* (Acari: Prostigmata: Cunaxidae) in the Hawaiian Islands — Anales Inst. Biol. Univ. Nac. Autón México, Ser. Zool., 67(2): 225-237.
- The Nature Conservancy, Ozarks ecoregional assessment team. 2003 — Ozarks ecoregional conservation assessment — The Nature Conservancy Midwestern Resource Office. Minneapolis, MN.
- Walter D.E., Kaplan D.T. 1991 — Observations on *Coleosirus simplex* (Acarina: Prostigmata), a predatory mite that colonizes greenhouse cultures of rootknot nematode (*Meloidogyne* spp.), and a review of feeding behaviour in Cunaxidae — Exper. Appl. Acarol., 12(1-2): 47-59. doi:10.1007/BF01204399
- Walter D.E., Hunt H.W., Elliott E.T. 1988 — Guilds or functional groups? An analysis of predatory arthropods from a shortgrass steppe soil — Pedobiologia 31: 247-260.
- Watson, S. 1891 — The relationship of the Mexican flora to that of the United States — Proc. Ameri. Assoc. Adv. Sci. 39: 291-292.

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