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Article

New records of soil mites from Pakistan, with description of a new species (Acari: Laelapidae)

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ABSTRACT
This paper records six species and five genera of mites in the family Laelapidae from soil in Punjab, Pakistan. Five species are recorded from Pakistan for the first time – *Euandrolaelaps karawaiewi* (Berlese, 1904), *Gaeolaelaps minor* (Costa, 1968), *Gymnolaelaps kabitae* Bhattacharyya, 1968, *Ololaelaps translineatus* (Barilo, 1991), and *Stratiolaelaps scimitus* (Womersley, 1956). *Cosmolaelaps lutosus* **sp. nov.** is described as a new species.

KEYWORDS: Biogeography, *Cosmolaelaps*, fauna, Mesostigmata, new species.

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INTRODUCTION

The mite family Laelapidae includes hundreds of species that occur in soil and litter and in the nests of vertebrates and arthropods (Evans and Till 1966; Lindquist *et al*. 2009). The non-parasitic species belong to the genus *Gaeolaelaps* Evans & Till, 1966 and its relatives, including *Hypoaspis* Canestrini, 1884, *Pseudoparasitus* Oudemans, 1902, *Ololaelaps* Berlese, 1904a, *Cosmolaelaps* Berlese, 1903, and *Stratiolaelaps* Berlese, 1916. Some species in these genera have established close phoretic or commensal relationships with other arthropods and vertebrates (Krantz 1998; Lindquist *et al*. 2009). Some species of Laelapidae have an important role in the control of pests in soil including insects and nematodes (Moreira and Moraes 2015), but their use in this way is hampered by the difficulty of identifying genera and species.

The soil Mesostigmata of Pakistan are very poorly known. The only significant work on the subject was by Allred (1969, 1970, 1975), who worked mainly on the species associated with small mammals. Qayyoum & Khan (2017) collected three species of Laelapidae from poultry manure in Punjab Province, but did not identify them to the species level. Ghaffar *et al*. (2019, 2020) collected Laelapidae in soil under citrus orchards, but did not identify them beyond the family level. Halliday *et al*. (2018) reviewed the mite fauna of Pakistan, including 36 species of Laelapidae. Most of those species are parasites, and only four can be considered as soil-dwelling predators – *Cosmolaelaps*

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vacua (Michael, 1891), *Gaeolaelaps quadridentatus* (Allred, 1970), *Laelaspis patulus* Allred, 1969, and *Stratiolaelaps miles* (Berlese, 1892). This lack of information makes it impossible to assess the ecological role of the soil-dwelling Laelapidae in that country. The present paper reports the first results of a study of the laelapid mites from soil in Punjab Province, Pakistan, and should provide a basis for future studies of the taxonomy and biology of the family.

MATERIALS AND METHODS

Mites were collected from soil samples from various localities of the Punjab province of Pakistan (Khan *et al*. 2017). Soil samples were collected from cultivated fields and the adjoining uncultivated land, including roadsides and river banks. All samples were collected from soil cores by A.K. Khan. Soil cores were 10.5 cm in diameter and 10 cm deep. Mites were extracted from soil samples using Berlese/Tullgren funnels. The extracted mites were stored in 70% ethanol, cleared in lactic acid, mounted in Hoyer's medium, and examined in phase contrast and differential interference contrast illumination. Line drawings were made using a drawing tube or from microphotographs. All the measurements are given in micrometres (μm). The notation for dorsal idiosomal setae follows that of Lindquist & Evans (1965). Other morphological terminology follows Evans & Till (1979). Idiosomal pore-like structures including gland pores and poroids were distinguished according to Athias-Henriot (1969, 1971, 1975). The classification used here follows Moraes *et al*. (2022). The holotype and paratypes of the new species are deposited in the Acarological Laboratory, Department of Entomology, University of Agriculture Faisalabad, Pakistan.

RESULTS

Cosmolaelaps lutosus sp. nov. (Figs. 1–12)

http://zoobank.org/urn:lsid:zoobank.org:act:E05ECFC0-1C14-4D72-8720-512F362ABF81

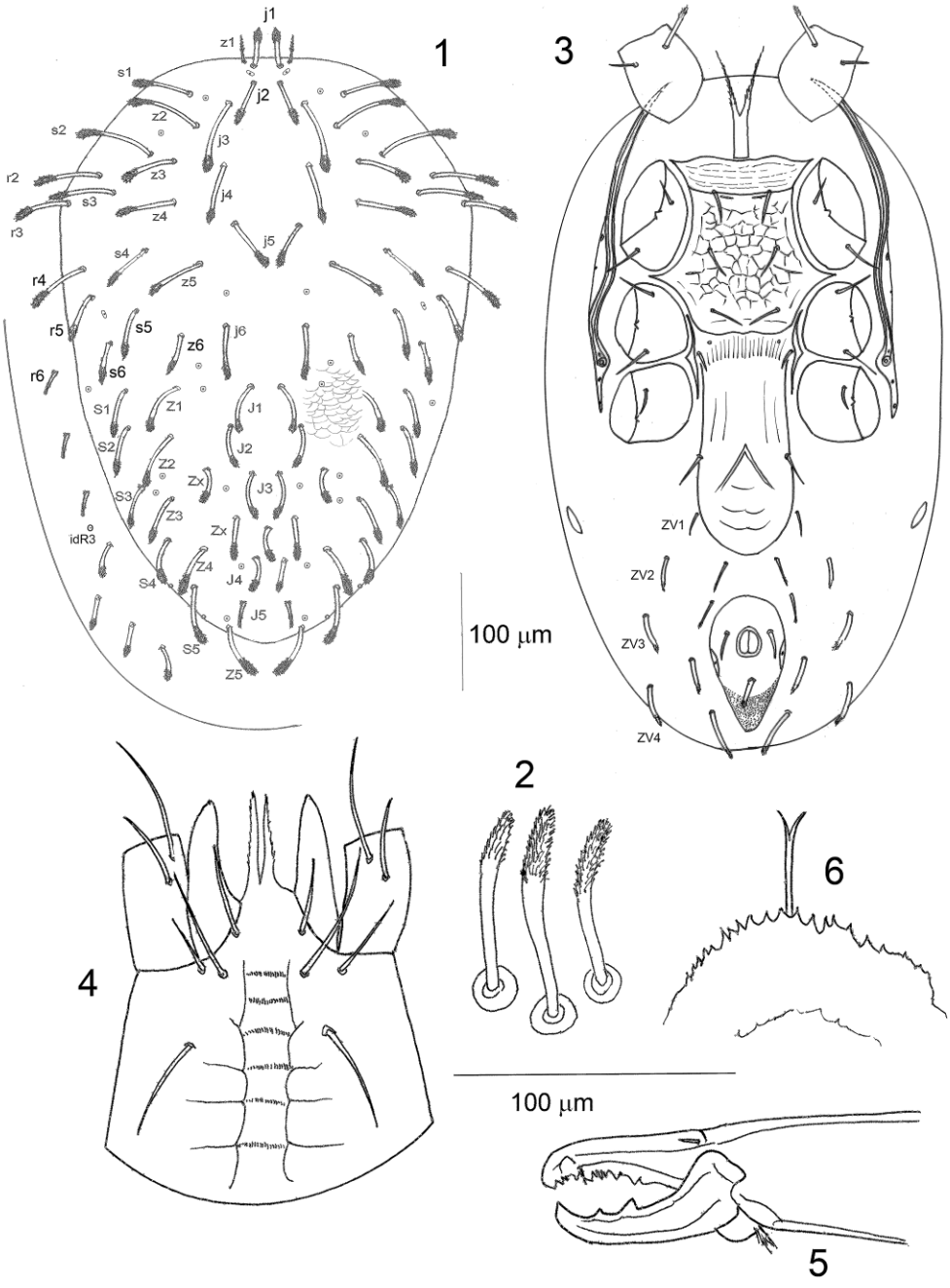
Specimens examined – Holotype female, University of Agriculture, Faisalabad, Punjab, Pakistan, 31° 26' N, 73° 04' E, 20 August 2014, soil core. Paratypes: 3 females, same data as holotype except 21 October 2014; 1 female, Dhannot, District Lodhran, Punjab, Pakistan, 29° 36' N, 71° 45' E, 21 June 2014, soil core; 1 female, Dhudial, Chakwal, Pakistan, 33° 03' N, 72° 57' E, 19 February 2014, soil core.

Female

Dorsal idiosoma (Fig. 1) – Female with doral shield tapering posteriorly, lightly sclerotised, pale yellow, not completely covering dorsal idiosoma; length 506 μm, width 294 μm, surface with faint polygonal ornamentation thoughout, with adhering fragments of soil and debris, and approximately 12 pairs of minute circular pores and two pairs of lyrifissures. Podonotal region with 23 pairs of setae, opisthonotal region with 17 pairs of setae including *Zx1* and *Zx2* between the *J* and *Z* setae. Three of the six specimens examined have single unpaired *Jx* seta between *J3* and *J4*. Seta *z1* fine, pointed, pilose, *J5* pointed, lightly pilose, all other setae distally expanded and pilose (Fig. 2). Setae *j3*, *j4*, *r3* longest (40–50 μm), *z1* and *J5* shortest (20–30 μm), others intermediate (30–40 μm). Opisthonotal soft cuticle with seven pairs of setae, three anterior pairs fine, four posterior pairs heavy and strongly pilose.

Ventral idiosoma (Fig. 3) – Tritosterum with trapezoidal base, pre-sternal area with transverse lineate ornamentation. Sternal shield with curved anterior margin and weakly concave posterior margin, with weak polygonal ornamentation, lateral corners fused with endopodal plates II/III, with three pairs of subequal smooth needle-like setae, *st1* on anterior margin of shield, and two pairs of lyrifissures. Metasternal setae *st4* and metasternal pore inserted in soft integument. Endopodal plates

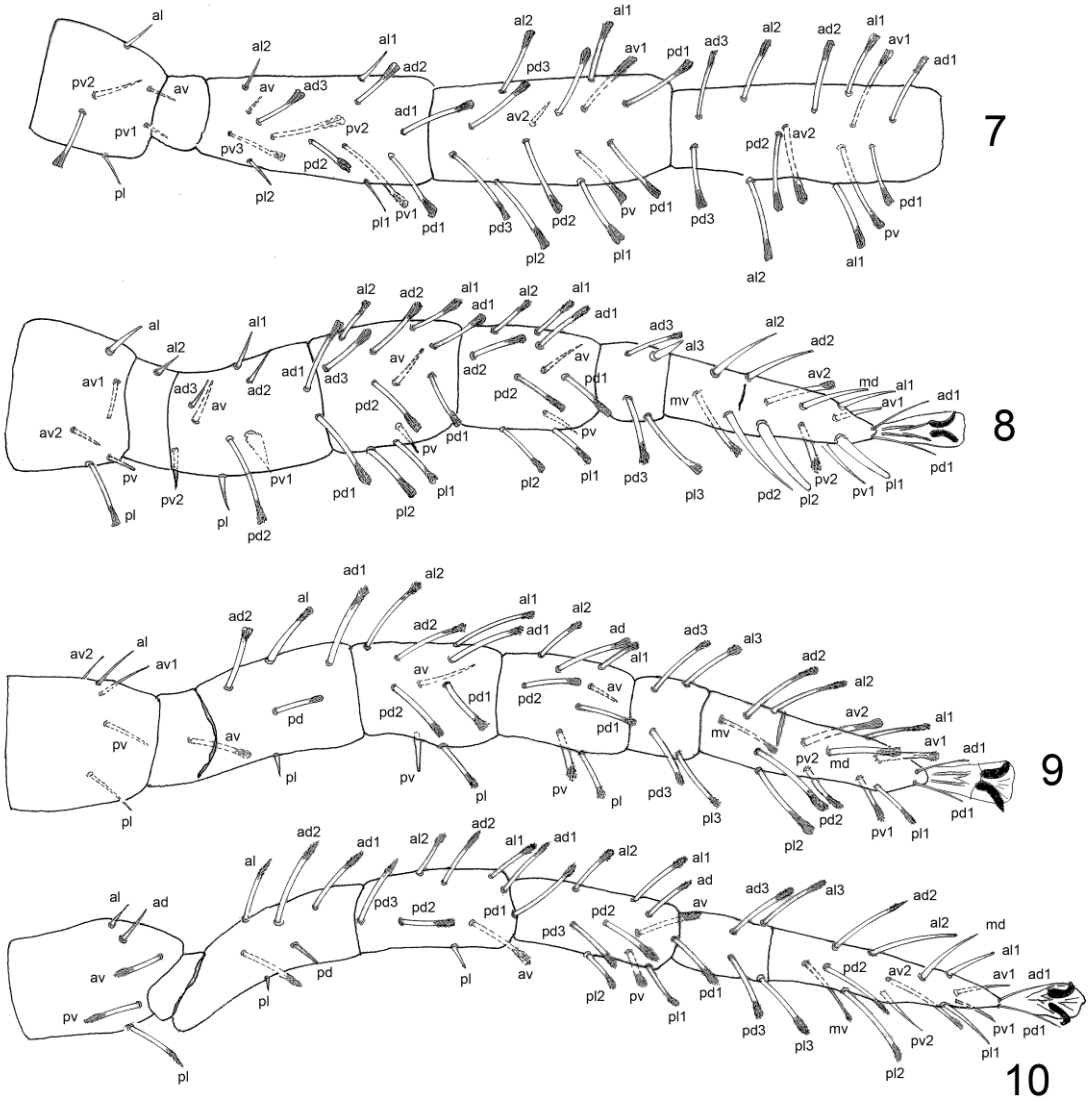
III/IV long, narrow, crescentic. Genital shield elongate, narrowest between coxa IV, weakly ornamented laterally and posteriorly, with one pair of smooth pointed setae. Anal shield longer than wide, with weak ornamentation laterally and smooth posteriorly, cribrum extending anteriorly past post-anal seta, post-anal seta thick and distally pilose, para-anal setae smooth and pointed; pore *gv3* on edges of shield, at posterior level of anus. Peritrematal shield very long and narrow except for a short section outside the peritreme opposite coxae II–III bearing a gland pore and a poroid; anterior end reaching *z1*, post-stigmatal section of peritrematal shield narrow, reaching mid-level of coxa IV; with one pre-stigmatic pore and two post-stigmatic pores. Opisthogastric integument with one pair of elongate metapodal plates and eight pairs of distally pilose setae, their length, thickness, and pilosity increasing posteriorly; opisthogastric pores not visible.



Figures 1–6. *Cosmolaelaps lutosus* **sp. nov.** (female) – 1. Dorsal shield; 2. Typical dorsal shield setae (not to scale); 3. Ventral idiosoma; 4. Hypostome; 5. Chelicera; 6. Epistome.

Gnathosoma – Hypostomal setae normal, deutosternal groove with six transverse rows of teeth, each row with about 20 fine teeth (Fig. 4), corniculi robust and horn-like, palp trochanter with two long pointed setae, other features of palp normal for genus. Movable digit of chelicera with two teeth, arthrodial brush with a circular membrane and several long bristles; fixed digit with six small proximal teeth, three distal teeth, and one large tooth near pilus dentilus, pilus dentilis fine and pointed (Fig. 5); epistome semi-circular, serrated, with a long underlying bifurcate process (Fig. 6).

Legs (Figs. 7–10) – Chaetotaxy typical for free-living Laelapidae as reported by Evans (1963): Leg I: coxa 0 0/1 0/1 0, trochanter 1 0/1 1/2 1, femur 2 3/1 2/3 2, genu 2 3/2 3/1 2, tibia 2 3/2 3/1 2. Leg II: coxa 0 0/1 0/1 0, trochanter 1 0/2 0/1 1, femur 2 3/2 2/1 1, genu 2 3/1 2/1 2, tibia 2 2/1 2/1 2, tarsus 3 3/2 3/2 3 + *mv*, *md*. Leg III: coxa 0 0/1 0/1 0, trochanter 1 0/2 0/1 1, femur 1 2/1 1/0 1, genu 2 2/1 2/1 1, tibia 2 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *mv*, *md*. Leg IV: coxa 0 0/1 0/0 0, trochanter 1 1/0 0/2 1, femur 1 2/1 1/0 1, genu 2 2/1 3/0 1, tibia 2 1/1 3/1 2, tarsus 3 3/2 3/2 3 + *mv*, *md*. Most dorsal and ventral setae thick, distally expanded and pilose; seta *pv1* on femur II short, thick, spine-like; *pl1* and *pl2* on tarsus II very thick and conspicuous.



Figures 7–10. *Cosmolaelaps lutosus* **sp. nov.** (female) – 7. Leg I, trochanter to tibia; 8. Leg II, trochanter to tarsus; 9. Leg III, trochanter to tarsus; 10. Leg IV, trochanter to tarsus.

Insemination structures – Not visible in the available specimens.

Etymology

The name *lutosus* (dirty) refers to the fragments of debris adhering to most of the specimens.

Notes

The genus *Cosmolaelaps* includes 135 species (Moraes *et al*. 2022). Attempts to develop a subgenus or species-group classification for these species have been unsatisfactory (for example Karg, 1988). We have checked the descriptions and illustrations of all the species of *Cosmolaelaps* listed by Moraes *et al*. (2022), with the exception of a few Berlese species that cannot be recognised. The dorsal shield setae in *Cosmolaelaps* are modified in various ways – expanded and leaf-like, scimitar-shaped with a basal swelling, terminally trifurcate, or with a longitudinal rib, but only a few species have distally pilose brush-like setae. A few pairs of opisthonotal setae are distally pilose in *C. bipennata* (Karg, 2003) and *C. brevilingua* (Karg, 2006) but most of the idiosomal setae in these species are smooth and pointed. The only other species that has distal pilosity on most of the dorsal shield setae is *C. kassaii* (Van Aswegen & Loots, 1970). However, *C. kassaii* has strongly developed exopodal plates, which are absent in *C. lutosus*. The anal shield of *C. kassaii* is almost circular, with a small cribrum confined to its posterior margin. In *C. lutosus* the anal shield is elongate and produced posteriorly, and the arms of the cribrum extend anteriorly beyond the post-anal seta.

Euandrolaelaps karawaiewi (Berlese, 1904)

Laelaps (*Androlaelaps*) *karawaiewi* Berlese, 1904b: 432.
Androlaelaps karawaiewi.— Bregetova, 1956: 82; Mrciak, 1963: 450; Shcherbak, 1969: 79; Ma, 1995: 159.
Hypoaspis karawaiewi.— Costa, 1968: 7; Koyumdjieva, 1981: 78.
Hypoaspis (*Euandrolaelaps*) *karawaiewi*.— Bregetova, 1977: 530.
Hypoaspis (*Pneumolaelaps*) *karawaiewi*.— Karg, 1979: 90; 1993: 149.
Pneumolaelaps karawaiewi.— Farrier & Hennessey, 1993: 86.
Euandrolaelaps karawaiewi.— Walter, 1988: 312; Hasanvand *et al*., 2014: 2868; Moraes *et al*., 2022: 238.

Specimens examined

One female, Rajhana, Toba Tek Singh, Pakistan, 20 April 2014, soil core, undisturbed soil, A.K. Khan coll.; 1 female, Basti Budhan, Pakistan, 28 April 2014, soil core, undisturbed soil, A.K. Khan coll.

Notes

Bregetova (1977) placed this species in *Hypoaspis* (*Euandrolaelaps*) Bregetova, 1977. Karg (1979, 1993) synonymised *Euandrolaelaps* under *Alloparasitus* Berlese, 1920, and transferred *L. karawaiewi* to *Hypoaspis* (*Pneumolaelaps*) Berlese, 1920. However, it cannot be placed in *Pneumolaelaps* as defined by Evans and Till (1966) because the peritreme is of normal width and genu IV has only one ventral seta. We agree with Moraes *et al*. (2022) in placing this species in *Euandrolaelaps* until the whole group can be thoroughly revised.

The diagnostic character states we used to identify the species are the modifications of leg II of the female, and the very short cheliceral digits. Femur II has a large ventral cuticular spur and a thickened ventral spine-like seta, there is a very large spine-like ventral seta on genu II, and thickened ventral setae on tibia and tarsus II (Costa 1968, his Figure 15). Our specimens also show the other distinctive character states described by Costa (1968) – movable digit of chelicera with a single tooth, corniculi elongate, and extreme differences in the lengths of the hypostomal setae. The species has

been recorded from Israel (Costa 1968), Iran (Kazemi and Rajaei 2013; Hasanvand *et al*. 2014), Russia (Berlese 1904b; Bregetova 1956, 1977), Bulgaria (Koyumdjieva 1981), Slovakia (Mrciak 1963), Latvia (Salmane 2001), China (Ma 1995) and USA (Walter 1988; Walter *et al*. 1988; Farrierand Hennessey 1993). It is now recorded from Pakistan for the first time.

***Gaeolaelaps minor* (Costa, 1968)**

Hypoaspis minor Costa, 1968: 9.
Hypoaspis minor.— Pramanik & Raychaudhuri, 1978: 6.
Gaeolaelaps minor.— Beaulieu, 2009: 36; Moraes *et al*., 2022: 264.

Specimens examined

Two females, Jhangiwala, Bahawalpur, Punjab, Pakistan, 29° 25' N, 71° 45' E, 30 June 2014, soil core, undisturbed soil.

Notes

Specimens of *Gaeolaelaps minor* are very small and lightly sclerotised, with a narrow and elongate dorsal shield. The epigynal shield is elongate behind setae *st5*, but does not reach the anal shield. The peritremes reach to the posterior level of coxa I. The anal shield is semi-triangular, widest in the anterior half. The ventral setae on tibia IV and genu IV are longer and thicker than the other leg setae. This species is unusual in the genus *Gaeolaelaps* in that the anterior margin of the sternal shield is strongly desclerotised, so that setae *st1* are inserted in soft granular skin in the pre-sternal area. Beaulieu (2009) reported only two species with this character state – *G. minor* and *G. franzi*(Van Aswegen and Loots 1970). Our specimens agree with the description of *G. minor*, with thesternal shield smooth, the sternal setae short, and hypostomal seta *h3* short. In *G. franzi* the sternalshield is ornamented, the sternal setae are much longer, and hypostomal seta *h3* is very long.
Geolaelaps minor has been reported from Israel (Costa 1968) and India (Pramanik and Raychaudhuri1978).

Bregetova (1977) provisionally proposed that *G. minor* could be a junior synonym of *Laelaps*(*Hypoaspis*) *expolitus* Berlese, 1904c, which was described from Italy. Berlese's illustrations of *L. expolitus* appears to show the unusual desclerotised anterior margin of the sternal shield. However ,the types of *L. expolitus* are missing or lost (Castagnoli and Pegazzano 1985), and no informationabout it has been published since the original description, so the proposed synonymy cannot beconfirmed.

***Gymnolaelaps kabitae* Bhattacharyya, 1968**

Gymnolaelaps kabitae Bhattacharyya, 1968: 537.
Pseudoparasitus (*Gymnolaelaps*) *kabitae*.— Karg, 1989: 334.
Pseudoparasitus (*Gymnolaelaps*) *hospes*.— Nemati *et al*., 2000: 381.
Laelaspisella kabitae.— Joharchi & Halliday, 2013: 47; Joharchi *et al*. 2016: 21.
Gymnolaelaps kabitae.— Nemati & Gwiazdowicz, 2016b: 45; Joharchi *et al*. 2020: 477; Moraes *et al*. 2022: 401.

Specimens examined

One female, Dhannot, District Lodhran, Punjab, Pakistan, 29° 36' N, 71° 45' E, 3 April 2014; 2 males, same data except 27 April 2014; 1 male, same data except 20 April 2014; 1 female, 3 males, Rajhana, Toba Tek Singh, Punjab, Paksitan, 30° 50' N, 72° 33' E, 27 October 2014; 1 male Dera Ghazi Khan, Basti Budhan, 29° 49' N, 70° 36' E, 18 August 2014, undisturbed soil; 1 male, same data except 28 February 2014; 1 male, Layyah, 30° 58' N, 70° 56' E, 27 April 2014, undisturbed soil.

Notes

Joharchi *et al*. (2016) referred to this species as *Laelaspisella kabitae*, using a broad concept of *Laelaspisella* Marais & Loots, 1969 that included six species. In a simultaneous paper, Nemati and Gwiazdowicz (2016b) used a narrow concept of *Laelaspisella* that includes only the two original species *L. epigynialis* Marais & Loots 1969 and *L. macrodorsalis* Marais & Loots, 1969. It is difficult to include *G. kabitae* in *Laelaspisella* without also including *Pogonolaelaps* Nemati & Gwiazdowicz, 2016b. Nemati *et al*. (2019) discussed the morphology of *L. kabitae* in detail, but could not decide on its generic placement. Moraes *et al*. (2022) also considered it as *incertae sedis*. We provisionally place *G. kabitae* in *Gymnolaelaps* until all these genera are thoroughly revised.

***Ololaelaps translineatus* (Barilo, 1991)**

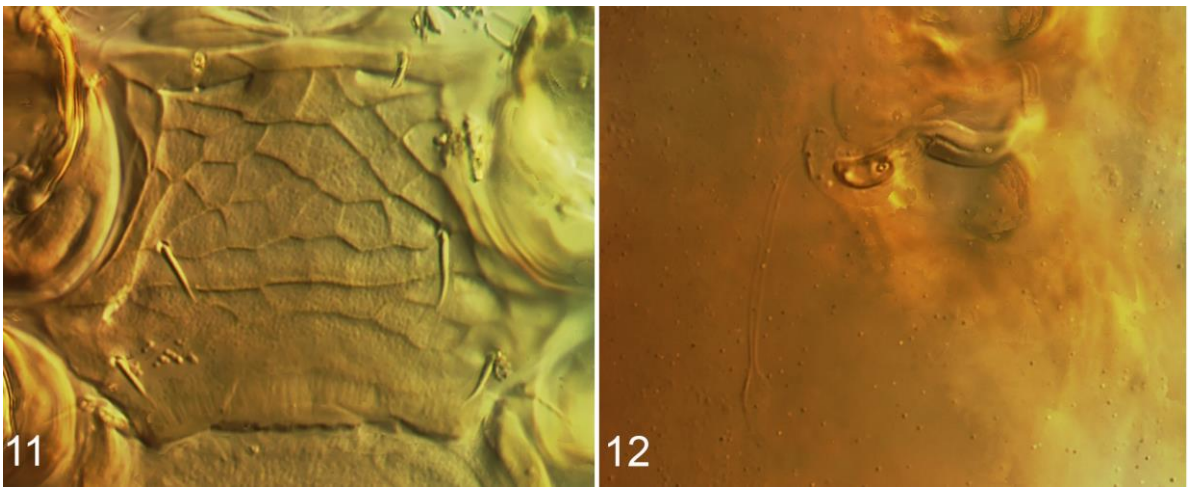
Pseudoparasitus (*Ololaelaps*) *translineatus* Barilo, 1991: 15.
Ololaelaps translineatus.— Beaulieu *et al*., 2019: 5; Moraes *et al*., 2022: 356.

Specimens examined

One female, Pakistan, Rajhana Toba Tek Singh, 30° 50' N, 72° 33' E, 1 August 2014, soil core, undisturbed soil.

Notes

Ololaelaps translineatus was described from Uzbekistan. It may be recognised by the distinctive transverse line across the sternal shield connecting the second pair of lyrifissures (Fig. 11), by the narrow fusion of the genito-ventrianal shield with the exopodal plates behind coxa IV, and by the form of the insemination ducts. Our specimen agrees well with the description and illustrations in Barilo (1991) and the diagnostic notes in Beaulieu *et al*. (2019) – posterior end of peritrematal shield free; posterior end of exopodal shield joined to genito-ventrianal shield by a narrow bridge; dorsal shield smooth; epipleura lineate/reticulate; metasternal setae inserted in a narrow strip of soft cuticle between the sternal shield and coxa III (Fig. 11); and spermathecal tubes as illustrated by Barilo (1991), beginning on the anterior margin of coxa IV on both sides, with a heavily sclerotised basal section leading to a membranous inner tubulus (Fig. 12). These character states distinguish *O. translineatus* from the species of *Ololaelaps* found in China (Bai *et al*. 1996; Liu and Zhang 2011; Ma 2015), Iran (Mahjoori *et al*. 2014), Egypt (Hassan 1989), and the former USSR (Bregetova and Koroleva 1964). Hussein *et al*. (2003) showed that *O. nasri* Hassan, 1989 feeds on nematodes and fly larvae, and may be a beneficial component of the soil fauna. The same may be true for other species of *Ololaelaps*.



Figures 11–12. *Ololaelaps translineatus* (Barilo, 1991) – 8. Sternal shield; 9. Insemination duct inside coxa IV.

Stratiolaelaps scimitus (Womersley, 1956)

Cosmolaelaps scimitus Womersley, 1956: 580.
Hypoaspis (*Cosmolaelaps*) *scimita*.— Tenorio, 1982: 267.
Stratiolaelaps scimitus.— Walter & Campbell, 2003: 266; Moraes *et al*., 2022: 392.

Material examined

Ten females, University of Agriculture Faisalabad, Pakistan, 20 August 2014, soil core, agricultural soil; 3 females, same data except 21 October 2014; 1 female, same data except 2 June 2014.

Notes

Allred (1969) recorded specimens identified as *Hypoaspis miles* (Berlese, 1892) associated with small mammals in Pakistan. Walter and Campbell (2003) discussed the difficulty of identifying species in this group, and we have not been able to examine Allred's specimens to confirm their identification. In view of the fact that *S. scimitus* is a widespread inhabitant of nests and burrows, we provisionally suggest that Allred's specimens from mammals in Pakistan were actually *S. scimitus*. These two species are distinguished by the shape of the opisthonotal shield (tapering gradually behind S2 in *S. miles*; tapering sharply behind S2 in *S. scimitus*), the length of the post-anal seta (much shorter than para-anal setae in *S. miles*; subequal to para-anal setae in *S. scimitus*), and the form of the palp tarsal claw (two subequal tines in *S. miles*, two subequal tines and a small basal tine in *S. scimitus*).

DISCUSSION

An improved knowledge of the mites of Pakistan will allow comparisons of its fauna with those of neighbouring countries. Unfortunately, the Laelapidae in this region are very poorly known. Prasad (1974) recorded 14 species of Laelapidae from India, most of them associated with mammals. A few species have been added since then, from the nests of birds (Bhattacharyya 1999) and mammals (Saxena 1999; Chaudhury *et al*. 2010), and from stored grain (Sandhu *et al*. 2005). Walia and Mathur (1994) sampled mites from arable soils at Haryana, India, and found that Laelapidae were capable of preying on nematodes. The Laelapidae of Afghanistan are almost completely unknown, except for a few species associated with rodents (Daniel 1977; Bukva and Amin 1983). The fauna of Laelapidae in Iran is much better known, with a series of recent studies leading to a total of about 40 species (Joharchi and Halliday 2013; Joharchi *et al*. 2016; Kazemi and Beaulieu 2016; Nemati and Gwiazdowicz 2016a, b; Babaeian *et al*. 2019; Kazemi *et al*. 2020; Joharchi and Halliday 2020). In Saudi Arabia, El-Bahrawy and Al-Dakhil (1993) and Asiry and Fetoh (2014) reported Laelapidae from rodents, and Fouly and Al-Rehiayani (2011, 2014) reported five predatory species from agricultural soils.

Among the species reported here from Pakistan, *Gaeolaelaps minor* and *Gymnolaelaps kabitae* also occur in India, and *Euandrolaelaps karawaiwei* and *G. minor* also occur in Iran. *Ololaelaps translineatus* occurs in Pakistan and Uzbekistan. The species identified in Afghanistan as *Hypoaspis miles* by Daniel (1977) could be the same as our *Stratiolaelaps scimitus*. The composition and distribution of this regional fauna will become clearer when more collecting is done, and when some provisional or incomplete identifications are confirmed.

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گزارش‌های جدید کنه‌های خاکزی از پاکستان، همراه با توصیف گونه‌ای جدید (Acari: Laelapidae)

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چکیده

در این مقاله شش گونه و پنج جنس هرنا از خانوادهٔ Laelapidae را از خاک پنجاب، پاکستان گزارش می‌شود. پنج گونه برای نخستین بار از پاکستان گزارش می‌شوند – *Euandrolaelaps karawaiewi* (Berlese, 1904)، *Gaeolaelaps minor* (Costa, 1968)، *Gymnolaelaps kabitae* Bhattacharyya, 1968، *Ololaelaps translineatus* (Barilo, 1991) و *Strateolaps scimittius* (Womersley, 1956). *Cosmolaelaps lutosus* **sp. nov.** به عنوان گونهٔ جدید توصیف می‌شود.

واژگان کلیدی: جغرافیای زیستی، *Cosmolaelaps*، زیاگان، میان‌سُفتیان، گونهٔ جدید.

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