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A new record of *Hypoaspis sardous* (Canestrini, 1884) (Acari: Mesostigmata: Laelapidae) from Korea

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Mite of the genus *Hypoaspis* of family Laelapidae are free-living soil predators mostly observed on the open grass field. Five species in the genus *Hypoaspis* were listed in Korean Catalog (NIBR, 2013) without detail information. Recent series of soil acarine biodiversity survey in Gyeongbuk and Gangwon provinces during 2009-2015 recovered a new record of *Hypoaspis sardous* (Canestrini, 1884) to Korean inventory from apple orchard and riparian grass land. Detailed description and morphological comparison with the related species, *H. aculeifer* which is well known biological control agent of horticultural crop pests were provided with identification keys.

Keywords: biological control, *Hypoaspis aculeifer*, Laelapidae, Nagoya protocol, predator

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Introduction

The mite family Laelapidae includes approximately 800 species of morphologically, ecologically and behaviorally dermanyssoid mites of Mesostigmata (Hallan, 2005). They inhabit soil-litter habitats and the nests of vertebrates and arthropods as obligate and facultative parasites of vertebrates, insect paraphages, and free-living predators that predatory laelapids tend to be voracious, polyphagous predator they reproduce quickly and can be reared easily (Walter and Oliver, 1989; Gillespie and Quiring, 1990; Lesna *et al*., 1995). These make them biological control agent of pests in soil such as *Hypoaspis aculeifer* (Beaulieu, 2009). Resource explorations of potentially important natural enemies are becoming more important after the Nagoya protocol of protecting the genetic resources. In Korea, 10 genera, 25 species are listed (NIBR, 2013).

The classification of family Laelapidae is unstable with different concepts of genera and subgenera for example, Evans and Till (1966), Van Aswegen and Loots (1970), Tenorio (1982) and Karg (1993). The subfamily Hypoaspidinae (Hypoaspididae of Karg, 1993) often are collected in litter and soil substrates and those often included, while other genera are routinely or occasionally encountered in the nests of mammals or arthropods or directly associated with insects (Evans and Till, 1966; 1979; Hunter and Rosario, 1988; Karg, 1993). The subfamily Melittiphidinae sensu Casanueva (1993) includes genera that have established close associations with ants and bees and they often appear in considerable numbers in host and hives (Lindquist *et al*., 2009). Adult of the melittiphidine tribe Varroini is now considered as family Varroidae (Casanueva, 1993). The Laelapinae includes a large number of genera that are primarily facultative nest parasites of rodents, although some have association with bats or primates (Radovsky, 1967; 1969; 1985) (as occurs also in the subfamily Hirstionyssinae).

This subfamily Hypoaspidinae is usually considered to comprise the genera *Hypoaspis* Canestrini, 1884 sens. lat. In the world, genus *Hypoaspis* Canestrini, 1884 were records total 10 genera, 224 species: subgenus *Hypoaspis*, *Euandrolaelaps*, *Holostaspis* (=*Olalaelaps*), *Laelaps*, *Gaeolaelaps*, *Alloparasitus*, *Hypohasta*, *Euryaspis*, *Hypoaspisella*, *Cosmolaelaps* (Hallan, 2005). The genus *Hypoaspis* as defined corresponds to the subgenus *Alloparasitus* they lack the diagnostic long Z4. Genital shield of female is much larger, almost reached to the anal shield. Genital shield setae have more than the normal genital shield setae. Genu IV is with eight setae. Peritrematic shield in the female free posteriorly and extending well beyond the posterior margins of coxae IV.

In Korea, five species were listed in the genus *Hypoaspis* of the family Laelapidae; *Hypoaspis aculeifer* Canestrini, 1884, *H. heselhausi* Oudemans, 1912, *H. heselhausoides* Seo, *H. kimunwani* Che and Seo and *H. murinus* Strandtmann and Menzies in KSP (1995) and the same information was available in KSSZ (1997) and NIBR (2013). Even though there are lists such as Korean zoological record (KSSZ, 1997) or Korean terminology of parasitology (KSP, 1995, http://web.donga.ac.kr/yjlim/5.htm), no taxonomic details are available on the species of the genus *Hypoaspis*. During the study of soil biodiversity, one newly recording *Hypoaspis sardous* (Canestrini, 1884) was recovered. This is the first description of *Hypoaspis* mite from Korea. Taxonomic details and identification key were provided.

Materials and Methods

We had conducted series of soil biodiversity study from diverse habitats of forest, agricultural, riparian soil from 2009 to 2015 (e.g. Jung *et al*., 2010; Keum and Jung, 2012; 2014). Soil mites were extracted using a modified Berless-Tullgren funnel (30W, 72 hrs) preserved in 70% ethyl alcohol, were mounted on slide glass using polyvinyl alcohol mounting medium (lactic acid, phenol, and poly vinyl alcohol; PVA medium; BioQuip Products, Inc.) (Downs, 1943), and the morphological observations, measurements, and illustrations were made using compound microscopes equipped with differential interference contrast and phase contrast optical systems, drawing tubes and stage-calibrated eyepiece micrometers. Setal notation for the idiosoma follows that of Lindquist and Evans (1965). Measurements of structures are given in micrometers (μm) and indicate the ranges among specimens measured. Dorsal shield lengths were taken as midline lengths from its anterior margin anterior to the base of vertex setae *j*1 to the caudal margin posterior edge. Specimens are deposited in Insect Ecology Lab, Department of Plant Medicine, Andong National University (ANU), Andong, Korea and also in NIBR, No. ZIIYIV0000003366.

Results and Discussion

Order Mesostigmata
Cohort Gamasina
Family Laelapidae Berlese, 1892 가시응애과
Genus *Hypoaspis* Canestrini, 1884 (가시응애속 (신칭))

Current list of *Hypoaspis* Canestrini, 1884 in Korea

***Hypoaspis aculeifer* Canestrini, 1884**
가는뿔다리좀진드기 (= 가는뿔다리좀응애, 총채가시응애)
Laelaps aculeifer Canestrini, 1884, Atti Ist. Veneto (6) 2: 698.
Hypoaspis aculeifer: Bregetova, 1956, Opred. Faune SSSR. 61: 77, figs. 102-106.
Hypoaspis aculeifer Canestrini; NIBR, 2013.

***Hypoaspis heselhausi* Oudemans, 1912**
큰순판가는다리좀진드기
Hypoaspis heselhausi Oudemans; KSSZ, 1997: 150.

***Hypoaspis heselhausoides* Seo** 가는다리좀진드기
Hypoaspis heselhausoides Seo; KSSZ, 1997: 150.

***Hypoaspis kimunwani* Che and Seo**
가는다리애기좀진드기
Hypoaspis kimunwani Che and Seo; KSSZ, 1997: 150.

***Hypoaspis murinus* Strandtmann and Menzies**
꼬불털가는다리좀진드기
Hypoaspis murinus Strandtmann and Menzies; KSSZ, 1997: 150.

New record of *Hypoaspis* Canestrini, 1884 in Korea

***Hypoaspis* (*Alloparasitus*) *sardous* (Berlese, 1911)**
Laelaps (*Androlaelaps*) *sardous* Berlese, 1911, Redia 7: 433.
Bregetova, 1956, Opred. Faune SSSR. 61: 83, figs. 120-122.
Hypoapis sardoa Evans and Till, 1966, Zool 14(5): 162, 175-177. fig. 20.
Hypoaspis (*Euandrolaelaps*) *sardous* Bregetova, 1977: 531, fig. 422.
Hypoaspis sardoa Karg, 1993: 140, fig. 101(b).
Syn.: *Hypoaspis laevis* var. pilifer Oudemans, 1912, Ent. Ber. Amst. 3: 231.

Material examined. Korea: 1♀, Gyeongsangbuk-do, Andong, 36°33′18.40″N, 128°40′46.47″E, 23 May 2009; 1♀, Yeongju, 36°50′44.44″N, 128°28′58.36″E, 27 April 2012; 1♀♀, Gangwon-do, Hoengseong, 37°31′32.44″N, 128°09′00.45″E, 12 April 2014 from apple orchard, riparian and grassland habitats by ES Keum and C. Jung.
Diagnosis. Female: Dorsal shield (580-680 μm long × 420-540 μm wide) with 39 pairs of setae. Surface of shield reticulated, no hypertrichy, one pair of *r* and six pairs of *R* setae on the cuticle. Sternal shield with three pairs of setae and two pairs of pores, metasternal setae free with associated pores. Genital shield is flask-shaped, with two pairs of setae. Peritreme extends to anterior margin of coxa II; preitrematic shield has anterior part fused with dorsal shield, posterior part free. Chelicera is bidentate; fixed digit with three teeth and a row of serra-

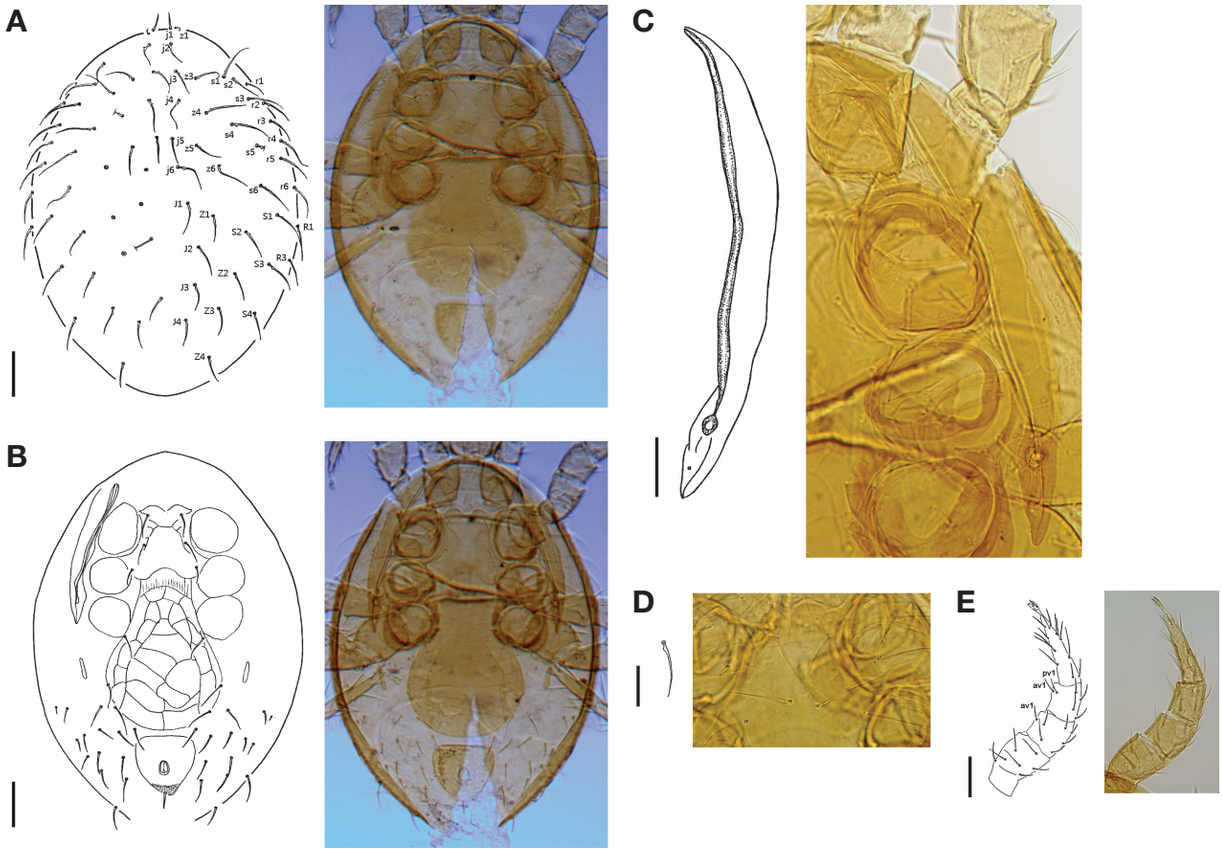


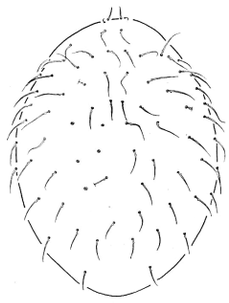
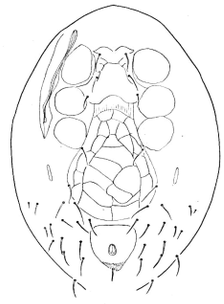
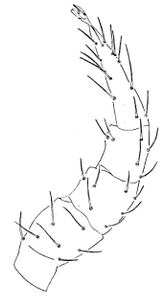
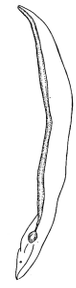
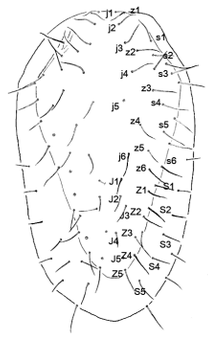
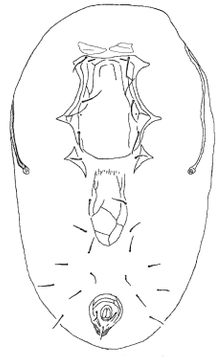
Fig. 1. *Hypoaspis sardous*. Female. A, Dorsal idiosoma; B, Ventral idiosoma; C, Peritreme; D, Dorsal seta; E, Leg II. Scale bars: drawing A, B = 40 μm, C-E = 100 μm.

Table 1. Morphological measurements of the body and appendages of *Hypoaspis sardous* and *H. aculeifer*

Species		Dorsal shield		Epigynal shield		Anal shield		Leg			
		Length	Width	Length	Width	Length	Width	I	II	III	IV
Hypoaspis sardous	1	580.0	440.0	255.0	205.0	105.0	95.0	455.0	355.0	260.0	455.0
	2	640.0	420.0	280.0	205.0	110.0	105.0	555.0	335.0	290.0	505.0
	3	680.0	540.0	290.0	200.0	145.0	100.0	625.0	340.0	365.0	545.0
Average		633.3	466.7	275.0	203.3	120.0	100.0	545.0	343.3	305.0	501.7
Hypoaspis aculeifer	1	550.0	360.0	70.0	50.0	75.0	50.0	420.0	370.0	350.0	550.0
	2	870.0	550.0	100.0	50.0	120.0	80.0	630.0	540.0	620.0	850.0
	3	660.0	350.0	155.0	65.0	65.0	55.0	520.0	330.0	325.0	495.0
	4	790.0	520.0	195.0	105.0	110.0	80.0	760.0	630.0	620.0	440.0
	5	650.0	390.0	155.0	65.0	75.0	60.0	540.0	405.0	350.0	580.0
	6	650.0	390.0	155.0	65.0	80.0	60.0	542.0	400.0	355.0	550.0
	7	670.0	400.0	160.0	90.0	55.0	75.0	540.0	380.0	355.0	530.0
	8	580.0	335.0	130.0	60.0	70.0	55.0	525.0	405.0	360.0	545.0
	9	650.0	360.0	160.0	65.0	75.0	55.0	465.0	405.0	370.0	570.0
	10	1000.0	640.0	210.0	110.0	120.0	90.0	735.0	615.0	660.0	910.0
Average		707.0	429.5	149.0	72.5	84.5	66.0	567.7	448.0	436.5	602.0

tions; pilus dentilis short, setiform. Four pairs of gnathosomal setae. Deutosternum with six transverse rows of denticles (4-8 per row); corniculi is long; internal malae fringed. Tectum capituli with denticulate anterior margin; salivary styli reach nearly to tips of corniculi. Pedipalp (2-5-6-14) with two-tined apotele. Chaetotaxy of

Table 2. Comparative morphology of *Hypoaspis sardous* and *H. aculeifer*

	Dorsal shield	Ventral shield	Dorsal setae	Leg II	Peritrematic shield
Hypoaspis sardous					
H. aculeifer					

legs differs from normal pattern in that tibia III and genu IV each have a second postero-lateral seta. Antero-ventral seta on femur II and genu II is spine-like, tibia III with two postero-lateral setae.

H. sardous differ to *H. aculeifer* by the presence of the diagnostic long seta Z4 and the shape of the dorsal setae. Epigynal shield of adult female of *H. aculeifer* is tongue-shaped and *H. sardous* is flask-shaped. Sternal shield of *H. aculeifer* is longer than broad or almost similar and anal shield is small. Peritrematic and exopodal shield of *H. aculeifer* are narrow. *H. sardous* is free of peritrematic shield. *H. aculeifer* have metapodal shield with setae. *H. sardous* is free. *H. aculeifer* is femur II with antero-ventral seta stout, spine-like, tarsus IV with long, stout, spine-like setae. *H. sardous* is antero-ventral seta on femur II and genu II spine-like, tibia III with two postero-lateral setae.

Male: not collected in Korea.

Remarks. This species has been reported from Europe and the USSR in litter, sweepings from warehouse floors, and in nests and rarely, on bodies of rodents (e.g. Bregetova, 1956; Evans and Till, 1966; Hughes, 1961; 1976). Costa and Nevo (1969) found it in nests of the mole-rat, *Spalax ehrenbergi* in Israel. Original description by Evans and Till (1966) described that Leg II bears several stout setae av1 and especially *av*2 on the femur of female. Dorsum of idiosoma shape is narrower than present study species and shape of setae in dorsal shield of female is different with original and present study specimen.

Distribution. Europe, USSR, Israel, Germany (Evans and Till, 1966), Korea (Andong, Yeongju, Hoengseong)

Deposition. NIBR No. ZIIYIV0000003366

Identifiers. Sławomir Kaczmarek and Eunsun Keum

Key to the species of *Hypoaspis*, family Laelapidae in Korea adopted Evans and Till (1966)

1. Deutosternum in both sexes with about eight denticles arranged in a single file. Cheliceral digits weakly dentate, pilus dentilis prominent. Dorsal shield with general hypertrichy. Anal shield or ventro-anal shield with posteriorly directed spur anterior to the anus ···· ····· subfamily Melittiphinae (Evans and Till, 1966)
− Deutosternum with seven to eight transverse rows of denticles, rows usually compound, but the proximal not associated with the lateral part of gnathosoma,

sometimes reduced to a single denticle. Pilus dentilies present. Chelicerae chelate-dentate or rarely, chelate-edentate. Dorsal shield *j*2 usually further away 2 times longer than *j*1, but not hypertrichy ····· ····· subfamily Laelapinae (Trägårdh, 1908)

− Deutosternum proximal reduced eight transverse rows of denticles, sometimes reduced to a single denticle. Gnathosoma is narrows proximally. Internal malae on gnathosoma is strong and diverse development. Dorsal shield with Zx setae pairs ····· ····· subfamily Hypoaspidinae Vitzthum, 1904 ··· 2

2. Female with anal shield completely fused with genito-ventral shield. Metasternal setae situated on sternal shield. Dorsal shield arched, completely covering dorsum of mite. Apotele with three unequal prongs ····· genus *Ololaelaps* Berlese, 1904

− Female with anal shield free. Metasternal setae not on sternal shield ····· 3

3. Genu IV with two postero-lateral setae, *pl*2 present. Pilus dentilis long, slender or inflated ····· 4

− Genu IV with one postero-lateral seta or if two, then pilus dentilis short, setiform ····· 7

4. Female with genital shield bearing the genital setae only ····· genus *Androlaelaps* Berlese, 1903

− Female with genito-ventral shield bearing three pairs of opisthogastric setae in addition to the genitals ··· 5

5. Medio-dorsal series of setae hypotrichous, *j*3, *J*3, *J*4 lacking. Femur I with setae *pd*1 arising from a strong, sclerotized protuberance ····· ····· genus *Ondatralaelaps* Evans and Till, 1965

− Medio-dorsal series of setae normal, comprising 11 pairs of setae. Setae *pd*1 on femur I not arising from a strong protuberance ····· 6

6. Genu III with nine setae. Dorsal setae rarely short, subspinose, *px*2 and *px*3 present. Male holo-ventral shield ····· genus *Laelaps* C.L. Koch, 1836

− Genu III with eight setae. Dorsal setae short, subspinose, never more than one pair of *px* setae. Male with sternito-genito-ventral and anal shield ····· ····· genus *Hyperlaelaps* Zachvatkin, 1948

7. Female with large genito-ventral shield bearing four or more pairs of setae of which two pairs are widely removed from its lateral margins. Pedipalpal apotele three-tined, posterior tine small ····· ····· genus *Pseudoparasitus* Oudemans, 1902

− Female with genital shield bearing genital setae only or if with genito-ventral shield, the additional setae are situated on its lateral margins. Pedipalpal apotele normally two-tined, rarely with three subequal tines ····· genus *Hypoaspis* Canestrini, 1884 ··· 8

8. Genital shield of female is much larger, almost reached to the anal shield. Genu IV with eight setae. Peritrematic shield in the female free posteriorly and extending to the margins of coxae IV ····· ····· *Hypoaspis* subgenus *Alloparasitus* Berlese ··· 9

− Adult female sternal shield longer than broad, presternal shield weakly sclerotized. Epigynal (= genital) shield tongue-shaped or flask-shaped, not markedly broadened posteriorly, and not touching anal shield. Peritrematic and exopodal shield narrow, not expanded posteriorly to coxae IV, and free from each other. Without dorsal or ventral hypertrichy, except for 0-3 additional unpaired median setae on dorsal shield. Anterior margin of tectum denticulate. Deutosternum with six (rarely five or seven) rows of denticles, with at least five denticles each (rarely three or four). Chelicerae chelate-dentate, well-developed ····· *Hypoaspis* subgenus *Gaeolaelaps* Berlese, 1924 ··· 10

9. Antero-ventral seta on femur II and genu II spine-like, tibia III with two postero-lateral setae. Dorsal shield with 39 pairs of setae ····· ····· *Hypoaspis* (*Alloparasitus*) *sardous* Berlese, 1911

10. Femur II with antero-ventral seta stout, spine-like, tarsus IV with long, stout, spine-like setae, genital shield small ····· *Hypoaspis* (*Gaeolaelaps*) *aculeifer* (Canestrini, 1884)

− Dorsal setae short, setae *J*1 reaching about mid-way between the bases of *J*1 and *J*2, genito-ventral shield sub-rectangular in outline with a pair of setae lying between the genito-ventral and anal shields ····· *Hypoaspis* (*Gaeolaelaps*) *heselhausi* (Oudemans, 1912)

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