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A new record of *Antennoseius avius* (Karg, 1976) (Acari: Mesostigmata; Ascidae) from Korea

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Mites of the genus *Antennoseius* of family Ascidae are free-living soil predator mostly observed on the open grass field. In Korea, only two species, *Antennoseius imbricatus* Ishikawa, 1969 and *A. japonicus* Ishikawa, 1979 were reported in 1990s. Recent series of soil acarine biodiversity survey in Gyeongbuk province during 2009-2015. We recovered a new record of *Antennoseius avius* (Karg, 1976) to Korean inventory from riparian grassland. Detailed description of the species as well as the identification key to the genus and species were provided.

Keywords: Ascidae, Korea, mite, predator, soil

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Introduction

Mites in the cohort Gamasina of Mesostigmata are free-living soil-dwelling predators. These mites are relatively abundant in soil with over five thousand species recorded (Lindquist *et al*., 2009). The group is characterized by having a bilateral extension of tracheal opening, stigmata in association with the peritreme which may have plastron function in some genera and allows long submergence (Koehler, 1999). Egg may be produced sexually or parthenogenetically. A six legged larva hatches which after two molts of protonymph and deutonymph develops into the adult with sexual organs. Gamasina are often used as soil bioindicators for reasons: their functional role in the soil ecosystem as predators, high species richness of the communities, intermediate abundances, robustness towards sampling and extraction methods, and good identifiability (Koehler, 1999).

The family Ascidae Viogts and Oudemans, 1905 was revised in 1965 by Lindquist and Evans with 22 genera. Then several new genera had been added. According to more recent concept of Lindquist *et al*. (2009), the family Ascidae includes two subfamilies, Ascinae and Arctoseiinae. This revised family concept is based on (I) posterior region of dorsal shield with setae *Z*5 generally inserted lateral to *J*5 on deutonymphs and adults; (II) female epigynal shield with posterior margin usually gently rounded or truncated; (III) female with anal shield usually oval or with ventrianal shield. The subfamily Ascinae sensu Lindquist *et al*. (2009) is equivalent in definition of Lindquist and Evans (1965). Attributes include: (i) dorsal shield setation generally holotrichous (setae *S*2 and *J*3 present); (ii) female with humeral setae *r*3-*r*6 usually on soft cuticle; (iii) female sternal shield often more weakly sclerotized anteriorly, such that setae *st*1 often on desclerotized cuticle or weak jugular platelets; (iv) male with endopodal shield alongside coxae III-IV usually free from or narrowly connected to sternitigenital shield; (v) arthrodial envelope at base of movable cheliceral digit not fimbriated; (vi) genu IV with nine setae, including *al*-2 and *pd*-3; (vii) tibia III with eight or nine setae, *al*-2 present, *pl*-2 present or absent; (viii) tibia IV with ten setae, including *al*-2, *pl*-2, and *pd*-3. These items (I), (II), (III) for the family and among items (iv) for the subfamily, all of which are homoplastic, the above character states for the family and subfamily readily accommodate *Antennoseius*. All aspects of the setation on legs I to IV of *Antennoseius* are typical of the subfamily Ascinae (Lindquist and Moraza, 2009). Species diversity of Ascidae encompasses 39 genera, 558 species in the world (Hallan, 2005) and 10 genera 12 species in Korea (NIBR, 2013).

Leg I of genus *Antennoseius* is usually longer than the idiosoma and tarsus I usually has no claws and pulvilli.

The sternal shield bears two or three pairs of setae and the metasternal setae are situated either on the integument or on the metasternal-endopodal shields. A drop-shaped genital shield and an anal or small ventri-anal shield are present. The peritrematic shield is produced behind coxa IV. The dorsal shields are ornamented by means of punctate lines forming a reticulate pattern. The anterior margin of the tectum has many denticles. The specialized seta on the palptarsus is two-tined. The male either has a holoventral shield or the sternal shield is free and only the ventral-anal shield fused with the peritrematic shield. The legs of the male are unarmed and similar to those of the female (Ryke, 1961).

In the world, *Antennoseius* species were reported from diverse open habitats such as meadows, fields and marshes and in the nests of rodents and birds, and adult female of several species are phoretic under the elytra of carabid beetles (Costa, 1969; Lindquist and Walter, 1989; Fain *et al*., 1995; Halliday *et al*., 1998; Eidelberg, 2000; Beaulieu *et al*., 2008). In Korea, two species of *Antennoseius* were reported *Antennoseius imbricatus* Ishikawa, 1969 (Jeonbuk, Jinan-gun, Mt. Maisan; Jeonju, Mt. Geonjisan) and *A. japonicus* Ishikawa, 1979 (Jeonbuk, Jeonju, Mt. Geonjisan) by Choi (1994). During the study of soil biodiversity, one newly recording *Antennoseius avius* (Karg, 1976) was recovered. 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 grassland 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; Bio-Quip 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 of the podonotal shield from its anterior margin anterior to the bases of vertex setae *j*1 to its posterior margin, and of the opisthonotal shield from its anterior margin to the caudal margin posterior edge of the cribrum. Specimens are deposited in Insect Ecology Lab, Department of Plant Medicine, Andong National University (ANU), Andong, Korea and also in NIBR, No. ZIIYIV0000001301.

Results and Discussion

Order Mesostigmata
Cohort Gamasina
Family Ascidae Oudemans, 1905 떠돌이응애과
Genus *Antennoseius* Berlese, 1916
떠돌이응애속 (신칭)

1. *Antennoseius imbricatus* Ishikawa, 1969
미늘등떠돌이응애
Antennoseius imbricatus Ishikawa, 1969: 123, figs. 27-34; Choi, 1994: 28(2), fig. 9.

2. *Antennoseius japonicus* Ishikawa, 1979
주걱등떠돌이응애
Antennoseius japonicus Ishikawa, 1979: 112, fig. 5; Choi, 1994: 28(2), fig. 8.

3. *Antennoseius avius* Karg, 1976
부채털떠돌이응애 (신칭)
Antennoseius avius Karg, 1976, 50(4):1-7.

Material examined. Korea: 1♀, Gyeongsangbuk-do, Yecheon-gun, Jibo-myeon, 36°34′14″N, 127°24′42″E; 1 deutonymph, Gumi, Haepyeong-myeon, 36°11′43.46″N, 128°22′08.79″E, 23 May 2009 collected from riparian grassland habitats by ES Keum.

Diagnosis. Female. Dorsal shield (500 μm long × 310 μm wide) has divided podonotal and opisthonotal shield. Dorsal shield has distinct developed with small tuberous-polygonal reticulate pattern. Dorsal seta wide feathered, vertex setae couple *j*1 especially and leaf mold, about so wide as long, with fan-shaped ripen. Sternal shield with *st*1-3, epigynal shield with *st*4-5, narrow and long round in the bottom. Leg I has longer than other legs, claw absent, four long setae. Digit fixed of the chelicera with saw-shaped teeth from 10 tooth formations, tectum with tri-parted, saw in edge, middle part short to the lateral part. This species differ to the other two previously recorded species of *Antennoseius imbricatus* and *A. japonicus* by differ vertex setae couple *j*1 especially and differ shaped setae in dorsal shield (*A. imbricatus*; simple setae and conical shaped setae, *A. japonicus*; lobed shaped setae, *A. avius*; wide feathered). *A. avius* is differ formation of digit fixed of chelicera with *A. imbricatus* and *A. japonicus*.

Male. Not collected in Korea.

Remarks. Karg (1976) had collected firstly of this species in sandy meadow soil in Central Europe.

Distribution. Hungary (Kontschán *et al*., 2016), Eastern

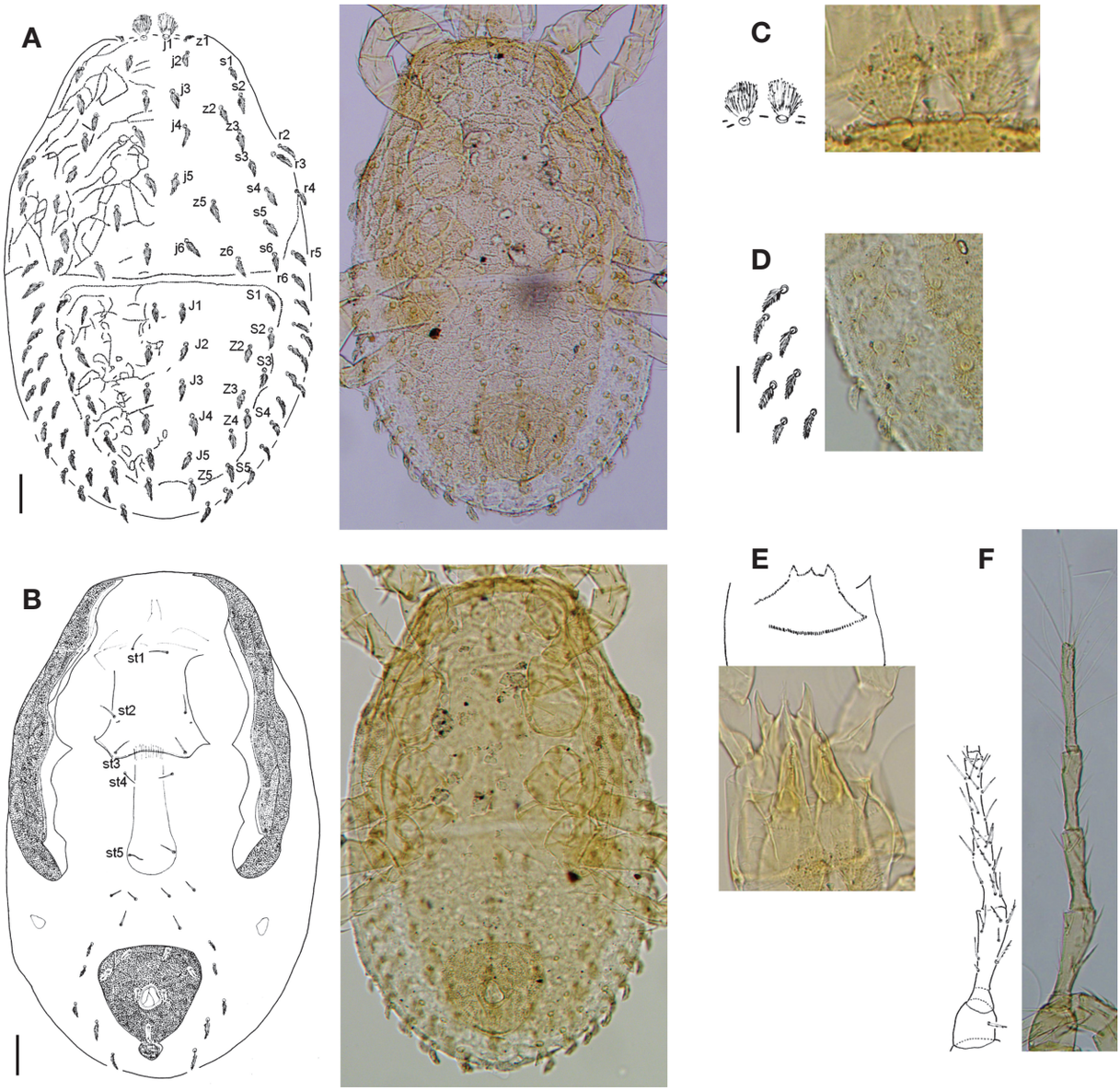


Fig. 1. *Antennoseius avius*. Female. A. dorsal idiosoma; B. ventral idiosoma; C. dorsal seta *j*1; D. dorsal seta; E. epistome; F. leg I. Scale bars: drawing A-F = 100 μm.

Austria (Wissuwa *et al*., 2012), Norway (Kalúz *et al*., 2013), Eastern Ukraine (Trach, 2013), Poland (Ujscie Warty National Park (Madej, 2000)), Korea (Yecheon, Gumi).

Deposition. NIBR No. ZIIYIV0000001301.

Identifiers. Sławomir Kaczmarek and Eunsun Keum.

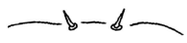
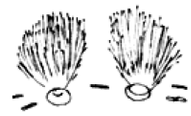
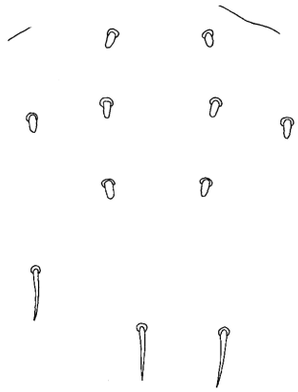
Key to the World Genera of Ascidae adopted from Halliday *et al.* (1998)

1. Dorsal shield of deutonymph and adult completely divided in two ····· 2
− Dorsal shield of deutonymph and adult entire, lateral incisions of deutonymphal shield retained or lost adult ····· 8
2. Opisthonotal shield with 12 pairs of setae (*J*3, *Z*2, *S*1 absent); podonotal shield lacking setae *j*2, *z*1, *z*3; adult leg setation strongly neotenous, genua I-II-III-IV with 11-8-7-7 setae, tibiae with 11-7-7-7 setae; female with anal shield ····· *Diseius*
− Opisthonotal shield with 15 or more pairs of setae (*J*3, *Z*2, *S*1 present); podonotal shield with setae *j*2, *z*3, sometimes *z*1; adult leg setation not strongly neo-

Table 1. Measurements of organs of *Antennoseius avius*.

	Dorsal shield		Podonotal shield	Opisthonotal shield	Anal shield		Leg I
	Length	Width			Length	Width	
Female	500	310	250	205	120	97.5	730
Deutonymph	430	270	203.5	185	95	85	625

Table 2. Comparison of three species of genus *Antennoseius* in Korea.

	Antennoseius imbricatus	*A. japonicus*	*A. avius*
*j*1			
Dorsal setae			
Chelicera			

tenous, minimum number of setae on genua 12-11-8-8, on tibiae 13-10-8-9; female with anal or ventri-anal shield ····· 3

3. Hypostome with corniculi bifid apically; anterior rostral setae thickened, spinelike; dorsal-shield setae z1 absent; female with oval anal shield bearing circum-anal setae only; male leg II conspicuously different from female, with a least one greatly thickened, spine-like seta on femur and tarsus ····· *Anephiasca*

− Hypostome with corniculi entire apically; anterior rostral setae of similar thickness to other hypostomal setae; dorsal-shield setae *z*1 present or absent; female with ventri-anal or subtriangular anal shield; male leg II similar to that of female, without spine-like setae ····· 4

4. Leg I usually without pretarsus and claws; female with subtriangular ventri-anal shield bearing 1 or 2 pairs of setae in addition to the circum-anal setae or with anal shield, and with epigynial shield strongly rounded posteriorly; male with ventri-anal shield united to peritrematic shields; deutonymph with anal shield; much of soft body cuticle often with microtu-

bercules superimposed on striae ····· 5
− Leg I with pretarsus and claws; female with ventri-anal shield variously shaped (but not subtriangular) bearing 3-6 pairs of setae in addition to circum-anal setae, and with epigynal shield truncate posteriorly; male with ventri-anal shield separate from peritrematic shields; deutonymph with ventri-anal shield; soft body cuticle striate, without microtubercles ····· 6
5. Palps slender, elongated, at least half as long as leg I; palp trochanter longer than femur; palp tibia almost 3 times as long as tarsus; sternal shield lacking lyrifissures iv1, iv3, and sometimes iv2; tibia IV with nine setae (*pl*-2 absent) ····· *Anystipalpus*
− Palps of normal length, about one-third as long as leg I; palp trochanter slightly shorter than femur; palp tibia twice as long as tarsus; sternal shield lyrifissures iv 1- iv3 present; tibia IV with ten setae (*pl*-2 present) ····· *Antennoseius*
− Leg I with pretarsus and a pair of small to well-developed claws ····· *Antennoseius* (*Vitzthumia*)
− Leg I lacking pretarsus and claws ····· ····· *Antennoseius* (*Antennoseius*)
6. Opisthonotal shield with setae *Z*4 and *S*5 usually approximal and inserted together on pair of prominent posterolateral tubercles; potonotal shield lacking setae *z*1, and with *j*2 well behind level of *j*1; peritrematic shields of adults broad, truncate posteriorly; genu I with 12 setae (*av*-2 absent) ····· *Asca*
− Opisthonotal shield with setae *Z*4, *S*5 well separated, not borne on pair of strong tubercles; podonotal shield with setae *z*1 present; *j*2 tending to be displaced anteriorly, often in approximately transverse row with *z*1 and *j*1; peritrematic shields of adults narrow or of moderate width, tapering posteriorly; genu I with 13 setae (*av*-2 present) ····· 7
7. Podonotal shield with transverse line extending completely across surfac at level of setae *z*6, opisthonotal shield with similar line at level of setae *J*1; para-anal setae inserted closer to anterior margin of anus than posterior margin; genu IV with 8 setae (*pl*-1 absent); tibia IV with 9 setae (*pl*-2 absent) ··· *Protogamasellus*
− Dorsal shields without transverse lines extending completely across surface; para-anal setae inserted closer to posterior margin of anus than to anterior; genu IV with 9 setae (*pl*-1 present); tibia IV with 10 setae (*pl*-2 present) ····· *Gamasellodes*
8. Leg II-IV with median lobe of pulvillus slender, acute or narrowly rounded; para-anal setae inserted level with or posterior to hind margin of anus, and usually longer than post-anal seta; femora I and II with 11 and 10 setae, respectively (each lacking v-3); anterior rostral and internal palp trochanter setae extremely long, whip-like, tapering only near tip ····· 9
9. Opisthonotal region of dorsal shield markedly hypotrichoous, with only 5 pairs of setae; female lacking metasternal shields and with anal shield; male lacking metasternal setae; median lobes of pulvillus of legs II-IV blunt; genu II with 9 setae (*pl*-2 absent) ····· ····· *Cheiroseiulus*

Key to the species of genus adult *Antennoseius* in Korea

1. Dorsal shield length 550 μm; podonotal shield simple pair 17 setae, four pair of conical shaped setae; opisthonotal shield pair 15 setae; digit fixed of chelicera is one teeth formation, moved of the chelicera is two teeth formation ····· *A. imbricatus* Ishikawa, 1969
2. Dorsal shield length 660 μm; podonotal shield lobed shaped pair 20 setae; opisthonotal shield pair 15 setae; digit fixed of chelicera is one teeth formation, moved of the chelicera is two teeth formation ····· ····· *A. japonicus* Ishikawa, 1979
3. Dorsal shield length 500 μm; podonotal shield wide feathered shaped pair 23 setae; opisthonotal shield pair 15 setae; digit fixed of the chelicera with saw-shaped, 10 teeth formation ····· *A. avius* Karg, 1976

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