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New records of Parasitidae mites (Acari; Mesostigmata) in Korea

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Korean fauna mites in the family Parasitidae of Mesostigmata were reported as 6 genera, 22 species. Among those 20 species were recorded from Northern part of Korea by Athias-Henriot (1977; 1980), Daele (1975) and Tichomirov (1977), but two from Southern part of Korea by Choi (1994) and Korean zoological record (KSSZ, 1997). During the faunal study of soil predatory mites of diverse habitats in South Korea, four species of *P. beta*, *P. fimetorum*, *P. insignis* and *Poecilochirus carabi* are the new records to Korean peninsula. Taxonomic details and other biological characteristics are reported.

Keywords: *Parasitus beta*, *Parasitus fimetorum*, *Parasitus insignis*, *Poecilochirus carabi*

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Introduction

Family Parasitidae is relatively large (many 1-2 mm) mite group with often yellowish to dark brown body color under the superfamily Parasitoidea in Cohort Gamasina of Mesostigmata among Acari (Lindquist *et al*., 2009). Known as predators, they feed on collembolans, dipterous larvae, mites, nematodes and other small soil dwelling animals. The family contains two subfamilies, the Parasitinae and Pergamasinae even with some disagreements on the lower level taxonomy with broader (e.g. Micherdzinski, 1969; Tichmirov, 1969; Karg, 1993b) and narrower view (e.g. Evans and Till 1979; Athias-Henriot, 1980; 1982b; Juvara-Bals, 2002). This study followed the concept of Athias-Henriot (1980; 1982b). In the subfamily Pergamasinae, male has the base of the tritosternum covered by the genital operculum and female has an undivided dorsal shield. Deutonymphs are not phoretic (Evans, 1992). They commonly inhabit relatively stable forest and grassland humus, moss, and soil ecosystems (Bhattacharyya, 1963; Holzmann, 1969; Karg, 1993b). Some members of the genus *Holoparasitus* are associated with wet habitats, such as fresh and saltwater marshes and beach wrack (Hyatt, 1987; Karg, 1993b). In the subfamily Parasitinae, male has the base of the tritosternum not covered by the genital operculum, and female has divided dorsal shields. They commonly occur in temporary accumulations of organic debris, including manure, vegetable compost and in the nest habitats of mammals and insects (Hyatt, 1980; Karg, 1993b). Deutonymphs are often phoretic on dung- or compost inhabiting insects (Scarabaeidae), bark-inhabiting beetles (Cerambycidae), or ground-nesting bees (Rapp, 1959; Binns, 1982). The occurrence of these often conspicuous mites on insect carriers was misconstrued as parasitism by early observers and apparently led to their being named *Parasitus* and "Parasitids" (Oudemans, 1936a).

Global diversity of Mesostigmata incompasses 100 families, 887 genera, 8,280 species, and that of Parasitidae comprises 2 subfamily 32 genera, 363 species in the world (Hallan, 2005). In Korea, 29 families, 92 genera, 237 species of Mesostigmata were recorded with 2 subfamily 6 genera, 22 species of Parasitidae (NIBR, 2013) (Table 1).

Among those 20 species were recorded from Northern part of Korea by Athias-Henriot (1977; 1980), Daele (1975) and Tichomirov (1977), but two from Southern part of Korea by Choi (1994) and Korean zoological record (KSSZ, 1997). During the faunal study of soil predatory mites of diverse habitats in Southern part of Korea, 13 species of Parasitidae mites were recovered. Among those, four species of *P. beta*, *P. fimetorum*, *P. insignis* and *Poecilochirus carabi* are the new records to Korean peninsula (Fig. 1). Taxonomic details and other biological characteristics are reported.

Materials and Methods

We had conducted series of soil biodiversity study

Table 1. Record distribution of mites in the family Parasitidae with subfamilies of Parasitinae and Pergamasinae from Korean peninsula

Subfamily	Species	Note	Region	Reference
	Anadenosternum (= *Parasitus*) *azaleensis*	S[1]	NK[3]	1
	Colpothylax exilis	R[2]	NK	4, 7
	Cycetogamasus corculatus	S	NK	4, 7
Pergamasinae	*C. coreanus*	S	NK	4, 7
	C. diviortus	R	NK	4
	C. insolitus	S	NK	4
	C. sguamatus	S	NK	4
	Eugamasus fujisanus	R	SK[4]	5
	E. oudemansi	R	SK	6
	Neogamasus bagyonensis	S	NK	2
	N. belemonphorus	S	NK	2
	N. cigulatus	S	NK	2
	N. eogenualis	S	NK	2, 7
	N. kengicus	S	NK	2, 7
	N. laciniatus	S	NK	2, 7
	N. mahunkai	S	NK	2, 7
Parasitinae	*N. similis*	S	NK	2
	N. simplex	S	NK	2, 7
	N. taeniiger	S	NK	2
	N. tikhomirovi	S	NK	2, 7
	N. wonensis	S	NK	2
	Parasitus consanguineus	R	NK	3
	*P. beta**	R	SK	7
	*P. fimetorum**	R	SK	7
	*P. insignis**	R	SK	7
	*Poecilochirus carabi**	R	SK	7

[1]S = new species, [2]R = new record, [3]N = North Korea, [4]S = South Korea, and [5]Reference; 1 = Daele, 1975; 2 = Athias-Henriot, 1977; 3 = Tichomirov, 1977; 4 = Athias-Henriot, 1980; 5 = Choi, 1994; 6 = KSSZ, 1997; 7 = this study

from diverse habitats of forest, agricultural, riparian soil habitats and animal nest of dung beetles 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 h) preserved in 70% ethyl alcohol, were mounted on slide glass using polyvinyl alcohol mounting medium (PVA medium) (Downs, 1943), then classified and identified under the compound microscope (×400). Total 13 of Parasitidae mites were recovered (Table 1). Among those, four species of *P. beta*, *P. fimetorum*, *P. insignis* and *Poecilochirus carabi* in the subfamily of Parasitindae are the new records to Korean peninsula. Illustration was made using compound microscope equipped with differential interference contrast and phase contrast optical systems, stage-calibrated eyepiece micrometers. Setal notation for the idiosoma follows that of Lindquist and Evans (1965). Measurements of structures are given in micrometers (μm). Dorsal shield lengths were taken as midline lengths of the idiosoma shield from its anterior margin to the bases of vertex setae *j*1 to the caudal margin posterior to the base of clunal setae *J*5.

Specimens are deposited in Insect Ecology Lab, Department of Plant Medicine, Andong National University (ANU), Andong, Korea and also in NIBR (NIBRIV0000325951, NIBRIV0000325952, NIBRIV0000325953, NIBRIV0000325954).

Results and Discussion

***Parasitus beta* Oudemans and Voigts, 1904**

Parasitus beta Oudemans and Voigts, 1904 in Voigts Oudemans, 1904: 652; 1905: 219.

Parasitus beta Oudemans and Voigts, 1904 sensu Karg, 1965; 303, fig. 59b, female only; 1971: 425, female only. *Parasitus beta* Ouds. and Voigts, 1904 (Deutonymph only described) = *P. fimetorum* Berlese, 1904, q.v.

Diagnosis Deutonymph: Podonotal shield with bears 20 pairs of setae and *s*2 being situated off the shield. Setae *j*1, *j*4, *z*5, *s*5, *s*6 and *r*3 are stouter than the remaining setae which are very fine. The longest and stoutest, *r*3 are also finely pilose. Opisthonotal shield with bears 15 pairs of setae of which three, *J*5, *Z*3 and *S*4, are clearly stouter than the other marginal setae. The tectum is trispinate with the centre prong usually giving the appearance of being damaged distally.

Male: The idiosoma length is 809 μm and with trans-

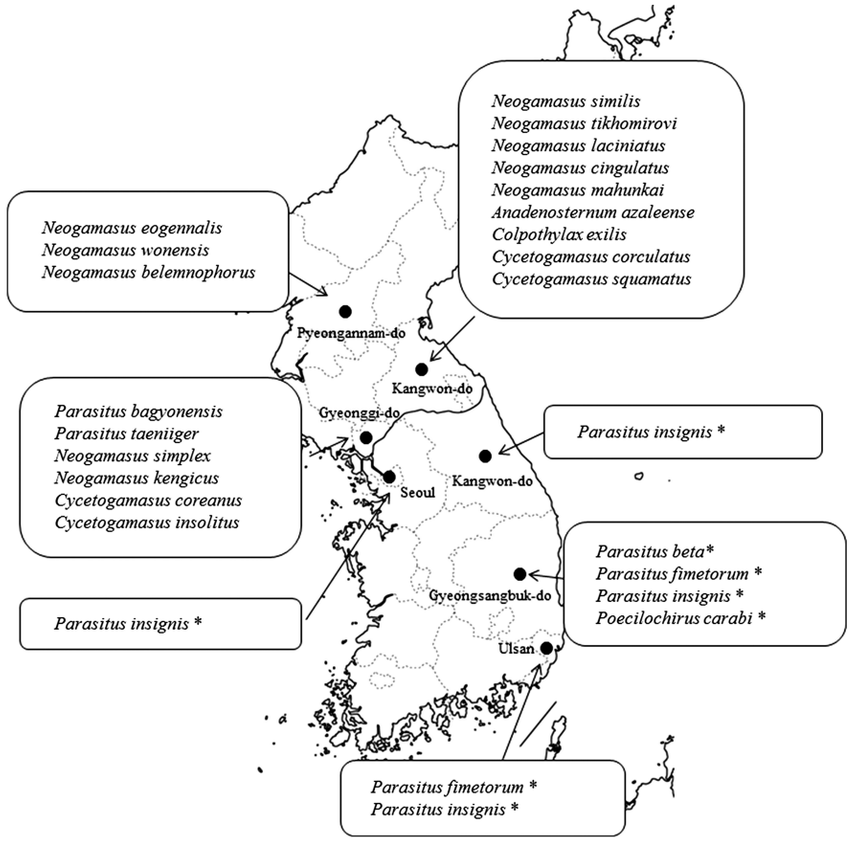


Fig. 1. Location of the sample collections of Parasitidae mite species for the new species or record description in Korea. Marked (*) are the new records to Korean fauna from this study.

verse structure. The podonotal region bears 21 pairs of setae of which *j*1, *j*4, *z*5, *s*5 and *r*3 are the stoutest. The remainder are slender. The opisthonotal region bears approximately 30 pairs of setae of which *Z*1 and *Z*3 are the stoutest and those towards the margins are amost as stout, whilst *J*1-*J*4 are slender. The tectum is trispinate, the centre spine being slightly the longest.

Female: The idiosoma length is 983 μm. Dorsal shield covering entire podonotal shield is finely reticulated and bears 21 pairs of setae of *j*1, *j*4, *z*5 and *r*3 are longer and stouter. Setae *s*5 is also stout but not long. The opisthonotal shield is also reticulated and bears 26 pairs of setae of *Z*1, *Z*3 and *J*5 are the stoutest and are finely pilose at least distally. The genital shield is strongly pointed anteriorly, whilst posteriorly it merges with the weakly sclerotized but reticulated opisthogastric shield. The endogynium show a mushroom-shaped process. The tectum is trispinate with the centre prong multifid (Fig. 2).

Material examined. Total 42 individuals (deutonymph, female and male) collected from riparian grassland and apple orchard grassland habitats. Information of sampling and habitats are detailed in Tables 2 and 3.

Voucher specimen deposition. Adult female, NIBR No. NIBRIV0000325951.

Distribution: England, Scotland, Ireland, Germany (Hyatt, 1980), South East Slovakia (Mašán and Stanoko, 2005), Poland (Błoszyk *et al*., 2005; Gwiazdowicz and Klemt, 2004), Hungary (Salmane and Kontschán, 2005), Gyeongsangbuk-do, Korea (this study).

***Parasitus fimetorum* (Berlese, 1904)**

Gamasus fimetorum Berlese, 1904a: 238; 1906: 135.
Eugamasus fimetorum Holzmann, 1969: 14.
Parasitus affinis Oudemans and Voigts, 1904 in Voigts and Oudemans, 1904: 652. Syn. nov.
Parasitus hibernicus Turk and Turk, 1952: 475, Syn. nov.

Diagnosis Deutonymph: The idiosoma length is 605-808 μm. The dorsal shields are strongly sclerotized, entirely reticulated and of noticeably constant outline. The podonotal shield bears 20 pairs of setae, *s*2 being situated off the shield. Setae *j*1, *j*4, *z*5 and *r*3 are considerably stouter and longer than the remainder, in this species, extremely fine and slender. The longest setae, *r*3

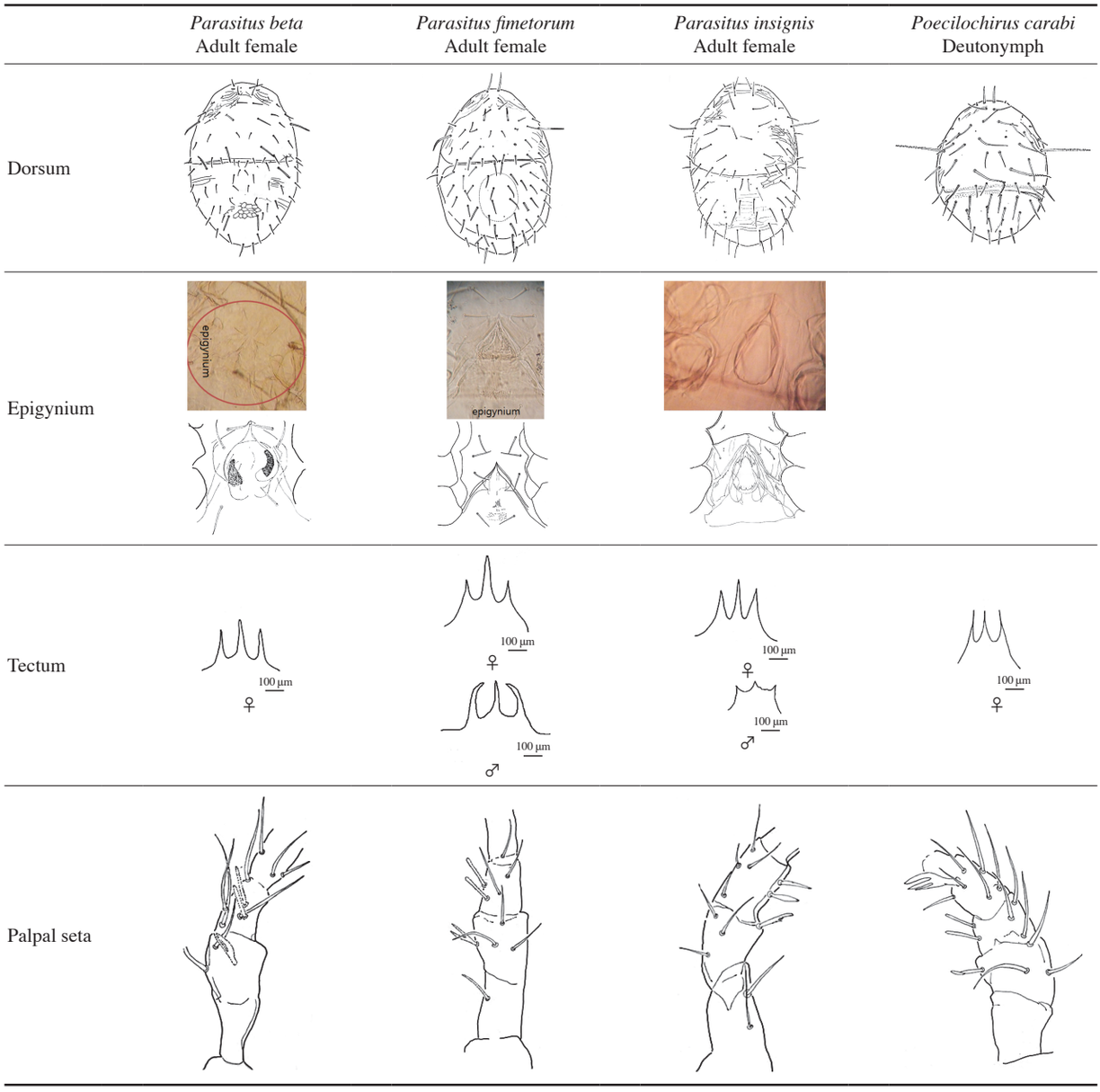


Fig. 2. Morphological characteristics of four newly found Parasitinae mites in this study.

are finely pilose. The opisthonotal shield bears 15 pairs of setae of two *J*5 and *Z*3. The tectum is tripinate with the centre prong almost invariably broken off or even deformed. The palp femur is shown in Fig. 2. The two anterolateral setae on the palp genu are spatulate.

Male: The idiosoma length is 804-936 µm and entire with a transverse suture. The dorsal chaetotaxy does not exhibit such extremes of setal length, setae *j*5, *j*6 and *J*1-*J*4 are noticeably finer than the surrounding setae. The podonotal region bears 21 pairs of setae of *j*1, *j*4, *z*5 and *r*3 are conspicuously longer and stouter than the remainder. The opisthonota region bears approximately 31 pairs of setae of *Z*3 are apparently the stoutest, although *Z*2 and several in the S-series are almost as stout. The tectum is trispinate with the outside prongs curved inwards, whilst the centre prong is either plain or forked at its tip (Fig. 2).

Female: The idiosoma length is 878-997 µm. The podonotal shield bears 21 pairs of setae of *j*1, *j*4, *z*5 and *r*3 are conspicuously longer and stouter than the remainder and are usually finely pilose. The opisthonotal shield bears 26 pairs of setae of *Z*3 are usually the stoutest and are finely pilose. The genital shield is strongly pointed

Table 2. Description of sample collection sites, geographical information in this study

Species	Location[1]	Latitude	Longitude	Date
Parasitus beta	Sangju, GB	36°21′31″N	128°17′57″E	23 May 2009
	Andong, GB	36°32′30″N	128°47′58″E	24 Apr 2013
		36°32′47″N	128°31′34″E	23 May 2009
	Cheongsong, GB	36°17′29″N	129°00′40″E	24 Apr 2013
	Chilgok, GB	36°16′07″N	128°23′84″E	24 Apr 2013
Parasitus fimetorum	Uiseong, GB	36°21′20″N	128°41′29″E	15-16 May 2014
	Taehwa, Ulsan	35°32′52″N	129°17′44″E	03 Jun 2015
Parasitus insignis	Andong, GB	36°32′44″N	128°39′54″E	23 May 2009
		36°32′47″N	128°31′34″E	23 May 2009
		36°33′17″N	128°44′12″E	23 May 2009
	Cheongsong, GB	36°17′29″N	129°00′40″E	24 Apr 2013
		36°17′38″N	129°00′40″E	24 Apr 2013
	Chilgok, GB	36°03′33″N	128°21′14″E	24 Apr 2013
		36°03′36″N	128°21′13″E	24 Apr 2013
	Heongseong, GW	37°31′23″N	128°17′24″E	12 Jun 2013
	Sangju, GB	36°21′31″N	128°17′57″E	23 May 2009
	Gangdong, Seoul	37°32′26″N	127°09′18″E	09 May 2015
	Taean, CN	36°47′55″N	126°08′58″E	18 May 2012
	Yeongju, GB	36°50′38″N	128°28′56″E	24 Apr 2013
	Yeongju, GB	36°50′44″N	128°28′58″E	24 Apr 2013
Poecilochirus carabi	Andong, GB	36°32′37″N	128°48′02″E	11 Sep 2013

[1]Note: GB = Gyeongsangbuk-do, GW = Gangwon-do, CN = Chungcheongnam-do

Table 3. Habitat distribution of four newly found Parasitidae mites

Species	Forest			Agriculture field			Riparian	Insect	Total
	Coniferous	Deciduous	Grass land	Apple	Garlic	Cabbage		*Nicrophorus* (Silphidae)	
Parasitus beta				2			40		42
Parasitus fimetorum	1				284	1			286
Parasitus insignis	35	61	109	260		1	150		616
Poecilochirus carabi								26	26

anteriorly, but posteriorly it merges into the weakly sclerotized and narrow opisthogastric shield. The most conspicuous element of the endogynium, but there are often considerable distortion and displacement of the individual structures. The tectum is tripinate with the median prong either long and pointed or shorter and regularly bifid (Fig. 2).

Material examined. Total 286 individuals (deutonymph, female and male) collected from galic and cabbage field, common reed and barley habitats. Information of sampling and habitats are detailed in Tables 2 and 3.

Voucher specimen deposition. Adult female NIBR No. NIBRIV0000325952.

Distribution: England, Wales, Ireland (Hyatt, 1980), South East Slovakia (Mašán and Stanoko, 2005), Poland (Gwiazdowicz and Klemt, 2004; Błoszyk *et al*., 2005; Gwiazdowicz *et al*., 2006; Bajerlein *et al*., 2006), Hungary (Salmane and Kontschán, 2005), New Zealand (Macfariane, 2005), China (Ming, 1986), Israel (Costa, 1961), Iran (Kheradmand *et al*., 2007), Japan (Tagami, 2007), GB, Ulsan, Korea (this study).

***Parasitus insignis* (Holzmann, 1969)**

Eugamasus insignis Holzmann, 1969: 20.

Parasitus insignis Micherdzinski, 1969: 5333. Karg, 1971: 448.

Pergamasus (*Paragamasus*) *diviortus* Athias-Henriot, 1967: 23.

Parasitus (*Neogamasus*) *diviortus* Tichomirov, 1971: 804. Bregetova *et al*., 1977: 75, 77.

Diagnosis Female: The idiosoma length is 745-835 μm. The podonotal shield is finely granular, lightly but entirely reticulated, and bears 22 pairs of slender imple setae, the longest being *r*3. Setae *r*4 are situated on the shield. The opisthonotal shield is 27 slender simple setae on the left side and 25 on the right. The tectum is tripinate with the centre prong only slightly longer than the laterals (Fig. 2).

Material examined. Total 616 individuals (deutonymph, female and male) collected from coniferous, deciduous and grassland in forest, apple orchard grassland, cabbage field in agriculture field. Information of sampling and habitats are detailed in Tables 2 and 3.
Voucher specimen deposition. NIBR No. NIBRIV 0000325953.
Distribution: England, Germany (Hyatt, 1980), Poland (Gwiazdowicz and Kmita, 2004), Iran (Kazemi *et al*., 2013), Gangwon-do, GB, Chungcheongnam-do, Korea (this study).

***Poecilochirus carabi* G. and R. Canestrini, 1882**
Poecilochirus carabi G. and R. Canestrini, 1882: 56. Vitzthum, 1930b: 392. Micherdzinski, 1969: 629. Holzmann, 1969: 7. Karg, 1971: 420. Bregetova *et al*., 1977: 99, 101, 102.
Gamasoides carabi Halbert, 1915: 55.
Poecilochirus necrophori Vitzthum, 1930b: 392. Cooreman, 1943: 15. Neumann, 1943: 1-21. Turk and Turk, 1952: 480. Micherdzinski, 1969: 633. Holzmann, 1969: 7. Karg, 1971: 419. Bregetova *et al*., 1977: 99, 101. Syn. nov.
Poecilochirus fucorum (De Geer) sensu Berlese, 1892b, Fasc. 69: No. 4, figs. 1-4.
Gamasoides eurasiaticus Trägärdh, 1937: 8. Willmann, 1939a: 438. Micherdzinski, 1969: 633. Davydova, 1976: 103.
Gamasus stygius Hull, 1918: 85. Holzmann, 1969: 7. Micherdzinski, 1969: 629.

Diagnosis Deutonymph: The idiosoma length is 521-985 μm. The podonotal shield is well sclerotized, granular and entriely reticulated. It bears 21 pairs of setae of *z*1, *s*1 and *s*2 are very short and peglike. The remain setae are stout and of varying lenghts with *z*5 and *r*3 the longest. The opisthonotal shield is of similar texture to the podonotal shield. It bears 13 pairs of homogeneous setae of variable lenght which have traces of pilosity at their tips. The posterior membrane bears short setae. The endopodal shields are generally darkly sclerotized, especially at coxae IV. The opisthogastric setae are fine and simple the anal shield is elliptical, reticulated and granular, and the paranal setae are slender, the postanal stouter. The peritreme extends to coxa I. The tectum comprises a sharply tapered central prong flanked a pair of inwardly curved side prongs (Fig. 2). The chaetotaxy of the palp trochanter, femur and genu is as in Fig. 2, with the anterolateral setae on the femur and genu alike, broadly spatulate distally, whilst the distal dorsal seta on the femur is noticeably stout and finely pilose in its distal half (Fig. 2).
Material examined. Total 26 deutonymphs. This species were found *en mass* from the carrion beetles of the genus *Nicrophorus* (Silphidae) as in the deutonymphal stage of phoretic interaction during autumn season. Information of sampling and habitats are detailed in Tables 2 and 3.
Voucher specimen deposition. NIBR No. NIBRIV 0000325954.
Distribution: England, Wales, Scotland (Hyatt, 1980), Japan, Europe, Russia, China, USA (Takaku *et al*., 1994), GB, Korea (this study).

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