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 tri-tosternum 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 tri-tosternum 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 encompasses 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, 4 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
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 Berlese-Tullgren funnel (30W, 72 h) preserved in 70% ethyl alcohol, were mounted on slide glass using polyvinyl alcohol mounting medium (PV A 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 j1 to the caudal margin posterior to the base of clunal setae J5.

Specimens are deposited in Insect Ecology Lab, Department of Plant Medicine, Andong National University (ANU), Andong, Korea and also in NIBR (NIBRIV 0000325951, NIBRIV0000325952, NIBRIV0000325953, NIBRIV0000325954).

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

| Subfamily | Species | Note | Region | Reference |
|-----------|---------|------|--------|-----------|
| Pergamasinae | Anadenosternum (=Parasitus) azaleensis | S1 | NK1 | 1 |
| | Colphothylax exilis | R2 | NK | 4, 7 |
| | Cycetogamasus corculatus | S | NK | 4, 7 |
| | C. coreanus | S | NK | 4, 7 |
| | C. diviorus | R | NK | 4 |
| | C. insolitus | S | NK | 4 |
| | C. squamatus | S | NK | 4 |
| | E. oudemansi | R | SK* | 5 |
| | Neogamasus hugyonensis | S | NK | 2 |
| | N. belenophonorus | S | NK | 2 |
| | N. cugilatus | 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 |
| | N. similis | S | NK | 2 |
| | N. simplex | S | NK | 2, 7 |
| | N. taeniliger | S | NK | 2 |
| | N. tikomirovi | 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 |

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

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 s2 being situated off the shield. Setae j1, j4, z5, s5, s6 and r3 are stouter than the remaining setae which are very fine. The longest and stoutest, r3 are also finely pilose. Opisthonomal shield with bears 15 pairs of setae of which three, J5, Z3 and J4, 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-
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 opisthonal region bears approximately 30 pairs of setae of which $Z_1$ and $Z_3$ are the stoutest and those towards the margins are almost 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 the stoutest. The remainder are slender. The opisthonal region bears approximately 30 pairs of setae of which $Z_1$ and $Z_3$ are the stoutest and those towards the margins are almost as stout, whilst $J_1$-$J_4$ are slender. The tectum is trispinate, the centre spine being slightly the longest.

**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, $r_3$
are finely pilose. The opisthonotal shield bears 15 pairs of setae of two J5 and Z3. 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 \( \mu m \) and entire with a transverse suture. The dorsal chaetotaxy does not exhibit such extremes of setal length, setae \( j5, j6 \) and \( J1-J4 \) are noticeably finer than the surrounding setae. The podonot al region bears 21 pairs of setae of \( j1, j4, z5 \) and \( r3 \) are conspicuously longer and stouter than the remainder. The opisthonota region bears approximately 31 pairs of setae of Z3 are apparently the stoutest, although Z2 and several in the S-series are almost as stout. The tectum is trisinate 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 \( \mu m \). The podonotal shield bears 21 pairs of setae of \( j1, j4, z5 \) and \( r3 \) are conspicuously longer and stouter than the remainder and are usually finely pilose. The opisthonotal shield bears 26 pairs of setae of Z3 are usually the stoutest and are finely pilose. The genital shield is strongly pointed.

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| Parasitus beta | Parasitus finetorum | Parasitus insignis | Poecilochirus carabi |
|---------------|---------------------|-------------------|---------------------|
| Adult female  | Adult female        | Adult female      | Deutonymph          |

**Fig. 2.** Morphological characteristics of four newly found Parasitinae mites in this study.
Table 2. Description of sample collection sites, geographical information in this study

| Species           | Location¹ | 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  |
|                   | Cheongsong, GB | 36°32′47″N | 128°31′34″E   | 23 May 2009  |
|                   | Chilgok, GB | 36°17′29″N   | 129°00′40″E   | 24 Apr 2013  |
|                   |           | 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  |
|                   | Cheongsong, GB | 36°33′17″N | 128°44′12″E   | 23 May 2009  |
|                   | Chilgok, GB | 36°17′29″N   | 129°00′40″E   | 24 Apr 2013  |
|                   |           | 36°17′38″N   | 129°00′40″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  |

¹Note: 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 |
|-------------------|--------------|------------------|----------|------------------------|-------|
| Parasitus beta    | Coniferous   | 2                | 40       | Nicrophorus (Silphidae)| 42    |
| Parasitus fimetorum | Deciduous   | 1                | 284      | 1                      | 286   |
| Parasitus insignis | Grass land  | 35               | 61       | 109                    | 616   |
| Poecilochirus carabi | Apple      | 260              | 1        | 150                    | 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 garlic and cabbage field, common reed and barley habitats. Information of sampling and habitats is 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 (Macfarlane, 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.

Parasitus (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 r3. Setae r4 are situated on the shield. The opisthogastric 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 (Gwiadzowicz and Knita, 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. Davydova, 1977: 99, 101. Syn. nov.

Poecilochirus faucorum (De Geer) sensu Berlese, 1892b, Fase: 69: No. 4, figs. 1-4.

Gamasoides eurasiacus 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 entirely reticulated. It bears 21 pairs of setae of z1, s1 and z2 are very short and peglike. The remain setae are stout and of varying lengths with z5 and r3 the longest. The opisthognathic setae of is similar to the podonotal shield. It bears 13 pairs of homogeneous setae of variable length 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 opisthognathic 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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