INS. KOREANA, 20(3, 4): 265~280. December 30, 2003

Review of Korean Formicoxenini (Hymenoptera: Formicidae: Myrmicinae) in Korea

Dong-Pyeo LYU* and Wang-Su CHO

Central Post-entry Quarantine Station, 234-4 Mangpo-Dong, Paldal-Gu, Suwon, Gyeonggi-Do, 442-400, Korea; E-mail: myrmicinae@hotmail.com

Abstract As achievements of this study, genus *Cardiocondyla* Emery is recorded for the first time from Korea. The tribe Formicoxenini of Korea includes *Cardiocondyla nuda* Mayr, *Leptothorax acervorum* Fabricius, *L. congruous* Smith, *L. koreanus* Teranish, *L. nassonovi* Ruzsky, *L. rabaudi* Bondroit, *L. serviculus* Ruzsky, *L. spinosior* Forel, *L. tuberum* Fabricius. There are two doubtable records (*L. rabaudi* and *L. tuberum*) as any specimens preserved in Korea were not found through this study and these species may not occur in Korea. And, each species is noted with diagnosis, morphological information, and SEM photos.

Key words *Cardiocondyla*, *Leptothorax*, and new record

INTRODUCTION

Most species of the tribe Formicoxenini have a high diversity of social parasites. More than 10% of all socially parasitic ants belong to the Formicoxenini and it was suggested that social parasitism convergently evolved more than ten times in this taxon.

Eight species of only genus *Leptothorax* of the tribe Formicoxenini from Korean fauna have been so far by Collingwood (1976), Terayama *et al.* (1992), and Kim (1996). And, among the species of genus *Leptothorax*, there are doubtable records on the two species from Korean. In addition, we collected from March 1993 to September 2002, and newly found a genus *Cardiocondyla* which is new to the Korean peninsula. We provided redescription, illustration, keys, and remarkable characters on the species of genus *Cardiocondyla* and *Leptothorax* in this study.

Abbreviations used in this paper are as follows: GG, Gyeonggi-do; GW, Gangwon-do; CB, Chungcheongbuk-do; CN, Chungcheongnam-do; JB, Jeollabuk-do; JN, Jeollanam-do; GB, Gyeongsangbuk-do; GN, Gyeongsangnam-do; JJ, Jeju-do; TL, Type Locality.

SYSTEMATICS

Tribe Formicoxenini Forel, 1893

Formicoxenii Forel, 1893, Ann. Soc. Entomol. Belg. 37: 164. Type genus: *Formicoxenus* Mayr, 1855: 413.

Cardiocondylini Emery, 1914, Rend. Sess. R. Accad. Sci. Ist. Bologna 18: 36. Type genus: *Cardiocondyla* Emery, 1869: 20.

Leptothoracini Emery, 1914, Rend. Sess. R. Accad. Sci. Ist. Bologna 18: 38. Type genus: *Leptothorax* Mayr, 1855: 431.

* To whom correspondence should be addressed.

Podomyrmini Emery, 1922, Genera Insectorum 174C: 236. Type genus: *Podomyrma* Smith, 1859: 145.
Formicoxenini: Bolton, 1994: 105.

Eyes well developed, at or about the midlength of the head. Antennae with 11 to 12 segments and apical 3 segments forming club, no antennal scrobes. Median portion of clypeus projecting over the base of the mandibles as a broad arcuate lobe. Alitrunk with the anterodorsal angles acute, giving a square-shouldered appearance. Promesonotal suture absent, metanotal groove weak or absent. Propodeum bidentate or bispinose. Petiole with a very short, thick anterior peduncle. Erect hairs on all dorsal surfaces and thick, short and blunt. Superficially they are like some *Tetramorium* but their sting has no apicodorsal lamelliform appendage. Monomorphic workers.

This tribe contains about 720 species in the worldwide.

Key to the genera of Formicoxenini in Korea, based on worker.

1. Petiole with anterior peduncle in length but usually long; postpetiole in dorsal view very broad, much broader than the petiolar node ..... ***Cardiocondyla* Emery**
- Petiole with anterior peduncle in length but usually short; postpetiole usually nodiform and without ventral process ..... ***Leptothorax* Mayr**

Genus *Cardiocondyla* Emery, 1869

Cardiocondyla Emery, 1869, Annali Accad. Aspir. Nat. Naspoli 2(2): 20. Type species: *Cardiocondyla elegans* Emery, 1869: 20.

Emeryia Forel, 1890, Ann. Soc. Entomol. Belg. 34: 110. Type species: *Emeryia wroughtonii* Forel, 1890: 111.

Xenometra Emery, 1917, Bull. Soc. Entomol. Fr. 1917: 96. Type species *Xenometra monilicornis* Emery, 1917: 96.

Loncyda Santschi, 1930, Rev. Suiss. Zool. 37: 70. Type species: *Cardiocondyla* (*Loncyda*) *monardi* Santschi, 1930: 70.

Dyclona Santschi, 1930, Rev. Suiss. Zool. 37: 70. Type species: *Monomorium cristatum* Santschi, 1912: 163.

Prosopidris Wheeler, 1935, Psyche 42: 40. Type species *Cardiocondyla* (*Prosopidris*) *sima* Wheeler, 1935: 41.

Worker. Small to minute monomorphic myrmicine ant. Dorsal surfaces of body usually without erect hairs. Mandibles with 5 teeth which decrease in size from apical to base. Palp formula 5 : 3. Frons with flattened and prominent projecting lateral portions which are fused to the raised projecting median portion to form a shelf which projects forward over the mandibles. sometime the lateral portions of the frons extend further forward than the median so that the anterior margin of the projecting shelf is concave medially. Median portion of frons inserted between small, narrow frontal lobes. Frontal carinae and antennal scrobes absent. Eye present, usually large and conspicuous, located on sides, in anterior half of the head. Antenna 11 to 12-segmented; usually with a distinct 3-segment club but the first club segment may be relatively small. Pronotal corners broadly rounded to bluntly angular and projecting. Promesonotal dorsum flattened to evenly convex in profile. Dorsum of alitrunk without sutures but the metanotal impression commonly present. Propodeal spiracle small, located approximately at the midlength, often down low on the side but not shifted back towards the margin of the declivitous face. Propodeum unarmed to having 2 long spines. Metapleural lobes low and rounded. Petiole with anterior peduncle. Postpetiole in dorsal view very broad, much broader than the petiolar node; in side view dorsoventrally flattened. Sting large and strongly developed; without lamelliform appendages.

Remarks. The genus and species are new to Korea. Characteristically rounded petiole

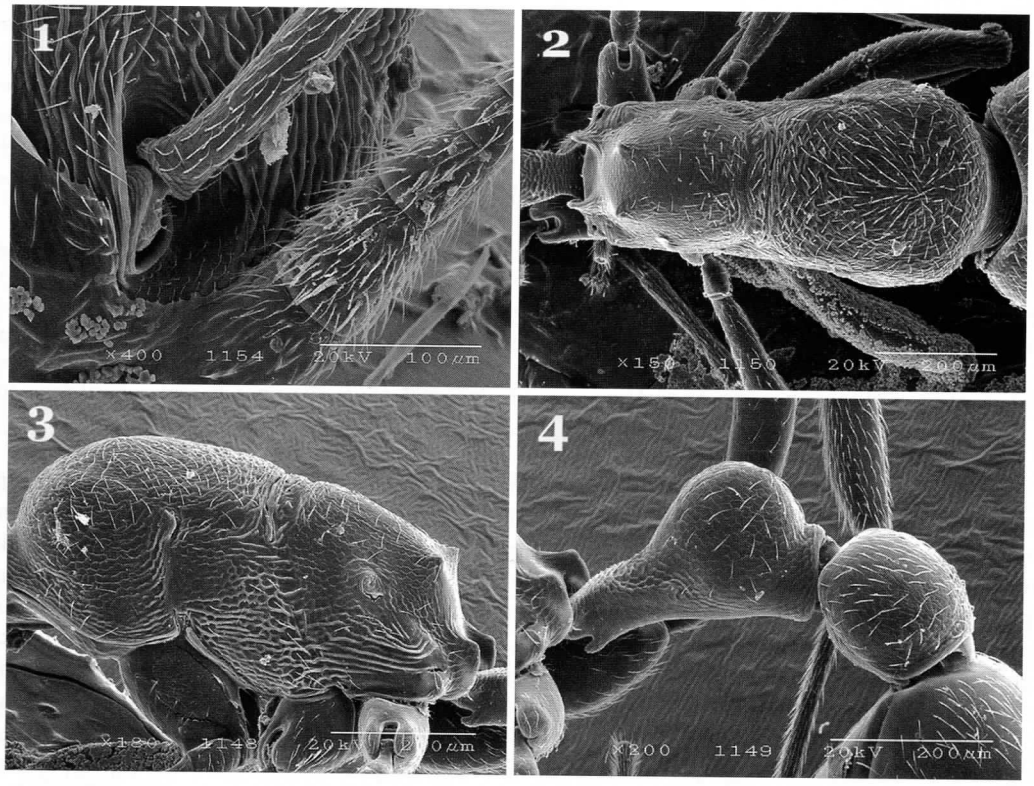
distinguishes this genus from other genera. Most species inhabit open areas, nesting in the soil; some nest in decaying tree branches or hollow grass stems. Several are known to produce ergatoid (wingless, more or less worker-like) males, either exclusively or dimorphically. *Cardiocondyla* includes about 40 species distributed mainly in the Old World tropics and subtropics, with some species in the Palaearctic region (Bolton, 1982).

1. *Cardiocondyla nuda* Mayr, 1866 둥근자루마디개미 (신칭) (Figs. 1-4)

Leptothorax nudus Mayr, 1866, Sitzungsber. Kais. Akad. Wiss. Wien Math.-Naturwiss. Cl. Abt. I 53: 508 [TL: Fiji Islands]; Wheeler and Wheeler, 1973: 27; Imai *et al.*, 1984: 6.
Cardiocondyla nuda minutior Forel, 1899: 120 [TL: USA].
Cardiocondyla nuda atalanta Forel, 1915: 75 [TL: Australia].

Worker. Total length of about 2 mm. Body dark brown to black; legs, antennae and mandibles brown. Head rectangular as long as wide; occipital border slightly convex. Mandibles each with 5 teeth, the apical largest. Scapes long, almost reaching occipital border of head. Metanotal groove shallow and weak in lateral view. Propodeal spines weakly developed, right-angled in lateral view. Petiole with a long peduncle, and with petiolar node inverted U-shape in profile; subpetiolar process small and spinose, situated on anteroventral portion of petiole. Postpetiole slightly lower than petiole in lateral view, as wide as long in dorsal view. Head and alitrunk sculptured; petiolar node, postpetiole and gaster smooth.

Specimens examined. [CB] 5 w, Mt. Heugseong-san, 8 VI 2000 (DP Lyu).



Figs. 1-4. *Cardiocondyla nuda* Mayr: 1. Antenna, base; 2. Alitrunk, dorsal view; 3. Pronotum, lateral view; 4. Petiolar node, lateral view.

Distribution. Korea (Central: new record) Russia and Japan.

Remarks. This is the first record of the species under newly recorded genus in Korea. It is polygynous, with a high queen/worker ratio. Shindo (1980) reported the average queen/worker ratio as 1 : 2. Colonies were divided multiply by budding. It has been suggested that *C. nuda* originated in tropical Africa and extended its range almost world-wide as a tramp species (Wilson and Taylor, 1967), but there have been no record from Africa.

Genus *Leptothorax* Mayr, 1855

Leptothorax Mayr, 1855, Verh. Zool.-Bot. Ver. Wien 5: 431. Type species: *Formica acervorum* Fabricius, 1793: 358.

Temnothorax Mayr, 1861, Die Europaischen Formiciden. (Ameisen.): 68. Type species: *Myrmica* (*Lieptothorax*) *recedens* Nylander, 1856: 94.

Macromischa Roger, 1863, Berl. Entomol. Z. 7: 184. Type species: *Macromischa purpurata* Roger, 1863: 184.

Dichothorax Emery, 1895, Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere 8: 323. Type species: *Leptothorax* (*Dichothorax*) *pergandei* Emery, 1895: 323.

Goniothorax Emery, 1896, Bull. Soc. Entomol. Ital. 28: 58. Type species: *Leptothorax vicinus* Mayr, 1887: 620.

Mychothorax Ruzsky, 1904, Zap. Imp. Rus. Geogr. Obshch. Obshch. Geogr. 41: 288. Type species: *Formica acervorum* Fabricius, 1793: 358.

Nesomyrmex Wheeler, 1910, Bull. Am. Mus. Nat. Hist. 28: 259. Type species: *Nesomyrmex clavipilis*, Wheeler, 1910: 259.

Tetramyrma Forel, 1912, Rev. Suisse Zool. 20: 766. Type species: *Dilobocondyla* (*Tetramyrma*) *brauni* Forel, 1912: 767.

Caulomyrma Forel, 1914, Bull. Soc. Vaudoise Sci. Nat. 50: 233. Type species: *Leptothorax echinatinodis* Forel, 1886, Ann. Soc. Entomol. Belg. 30: 48.

Antillaemyrmex Mann, 1920, Bull. Am. Mus. Nat. Hist. 42: 408. Type species: *Macromischa* (*Antillaemyrmex*) *terricola* Mann, 1920: 423.

Croesomyrmex Mann, 1920, Bull. Am. Mus. Nat. Hist. 42: 408. Type species: *Macromischa* (*Croesomyrmex*) *wheeleri* Mann, 1920: 422.

Myrmammophilus Menozzi, 1925, Atti Soc. Nat. Mat. Modena 55: 29. Type species: *Leptothorax* (*Myrmammophilus*) *finizii* Menozzi, 1925: 29.

Limnomyrmex Arnold, 1948, Occas. Pap. Natl. Mus. South. Rhod. 2: 222. Type species: *Limnomyrmex stramineus* Arnold, 1948: 223.

Myrafant Smith, 1950, Psyche 57: 30. Type species: *Leptothorax curvispinosus* Mayr, 1866: 508.

Icothorax Hamann and Klemm, 1967, Ann. Nat. Mus. Wien 70: 415. Type species: *Leptothorax* (*Icothorax*) *megalops* Hamann and Klemm, 1967: 417.

Meia Pagliano and Scaramozzino, 1990, Mem. Soc. Entomol. Ital. 68: 5. Unnecessary replacement name for *Goniothorax* Emery, 1896: 58.

Worker. Worker small and monomorphic. Head elongate, with rounded posterior corners and low occipital carina. Mandibles subtriangular and usually with 5 teeth (rarely 4 or 6 teeth) which decrease in size from apex to base. Palp formula 5 : 3. Frons narrow; anterior margin roundly projected; anterolateral portion not forming raised ridge in front of antennal insertion. Frontal carinae indistinct, anteriorly forming frontal lobes which cover antennal insertions. Antennal scrobes absent. Antennae 11 or 12-segmented in Korean species; scape not extending posterior border of head; apical 3 segments forming club. Compound eyes moderate to large in size, situated at or slightly anterior to the midlength of sides of head. Promesonotal region not raised; promesonotal suture absent dorsally; metanotal groove developed in various degree from shallowly to deeply impressed, or completely absent; propodeal spines present, but their shape varying with species from small dentiform to long and acute spines. Propodeal spiracle circular and frequently very small; usually located about the midlength of the

segment and located up high; never shifted back and down to a position close to the base of propodeal spine. Ventral processes of meso- and metasternum absent. Legs short; middle and hind tibiae without distinct spurs apical; claws small and simple. Petiole usually nodiform; anterior peduncle variable in length but usually short; often with a denticulate process on each side dorsally where peduncle meets node. Postpetiole usually nodiform and without ventral process. Sting strong and acute. Without apical or apicaldorsal lamelliform appendages; roughly circular in cross section, not knife blade-like. Pilosity usually short stout blunt hairs but sometimes hairs absent.

Female. General form of head as in worker, with larger compound eyes and small ocelli. Pronotum overhung by mesoscutum; mesonotum flattened dorsally; notauli absent, parapsidal furrows indistinct; mesoscutellum not overhanging metanotum; propodeal spines varying in shape with species as in worker. Legs, petiole, postpetiole and gaster like those of worker.

Male. Head small and subglobose, with low occipital carina. Mandibles narrow; masticatory margin dentate with one acute apical tooth followed by small denticles. Palp formula 5 : 3. Frons convex in the middle, projecting anteriorly; anterior margin widely rounded; anterolateral portion not forming carina; median portion of posterior margin produced posteriorly. Frontal carina indistinct. Antennal insertion exposed, close to posterior margin of frons. Antennae 13-segmented; scape short, not extending beyond outer margin of compound eyes; apical 4 segments of funiculus forming club. Compound eyes large and prominent. Ocelli well developed. Mesonotum overhanging pronotum; notauli and parapsidal furrows impressed on mesoscutum; mesoscutellum convex, not overhanging metanotum; propodeal spines varying in shape, usually more obtuse than those in conspecific worker. Ventral processes absent as in worker and female. Legs long and slender; apical spurs on middle and hind tibiae like those of worker. Petiole with more rounded and lower node than worker, lacking subpetiolar process. Postpetiole like that of worker. Hypopygium longer than broad. Genitalia retractile; basal ring thin; paramere with small gonocoxal arm and rounded apex; digitus sharply curved ventrally; cuspis reduced to small thin lamella; aedeagal plate with emargination at posteroventral portion and serrate ventral margin.

Remarks. Leptothorax resembles *Tetramorium* Mayr, but it is distinguished by the following characters (Bolton, 1982): (1) maxillary palpi 5-segmented (3 or 4 segmented in *Tetramorium*); (2) clypeus without carinae in front of antennal insertions (such carinae are present in *Tetramorium*); (3) mandibles generally with 5 teeth, rarely 6; the apical tooth largest and the others gradually smaller towards the base (seven teeth are usually present in *Tetramorium*, with the apical 3 largest). The genus is world wide in distribution, with most being found in the Holarctic region, including over 452 species. Some regional revisions include those of Creighton (1950) for North America, Kempf (1959) and Baroni Urbani (1978) for Neotropical, Bernard (1967) and Collingwood (1979) for the western European, Arnol'di (1977b) for USSR, and Bolton (1982) for Afrotropical species.

Key to the species of *Leptothorax* in Korea, based on worker

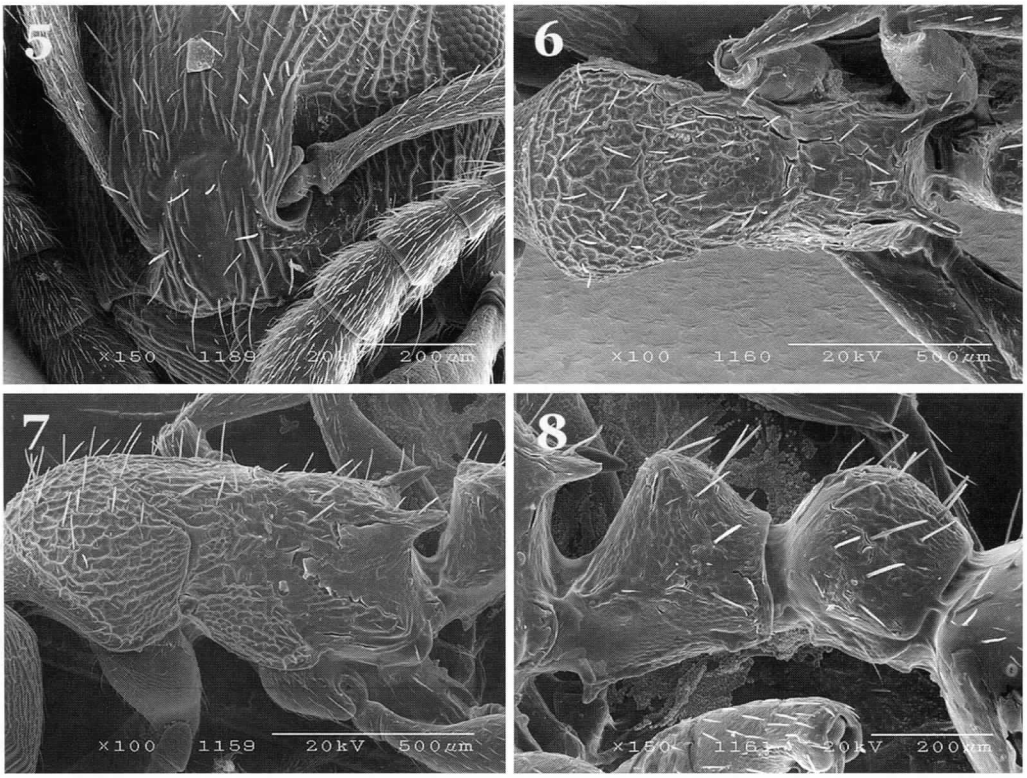
1. Body color black to dark brown; Antennae with 11 segments 2
- Body color brown to yellowish brown; Antennae with 11 or 12 segments 6
2. Anterolateral corners of pronotum angulate ..... ***koreanus* Teranish**
- Anterolateral corners of pronotum rounded, not angulate 3
3. Antennae with 11 segments; anterior slope of petiole relatively very steep in lateral view ..... ***acervorum* (Fabricius)**
- Antennae with 12 segments; Anteral slope of petiole relatively gentle in lateral view 4
4. Scapes long, almost reaching to exceeding the posterior border of head ..... ***spinosior* Forel**
- Scapes short, distinctly failing to reach the posterior border of head 5

5. Petiolar node triangular, its dorsal margin angulate in lateral view ..... ***congruus* (Smith)**
– Dorsal margin of petiolar node rounded in lateral view ..... ***serviculus* Ruzsky**
6. The front and dorsal surfaces of petiole a right angle ..... ***rabaudi* Bondroit**
– The front and dorsal surfaces of petiole rounded 7
7. Dorsum of alitrunk convex and short, with prominent in lateral view ..... ***nassonovi* Ruzsky**
– Dorsum of alitrunk convex without a break in lateral view ..... ***tuberum* (Fabricius)**

2. *Leptothorax acervorum* (Fabricius, 1793) 북방호리가슴개미 (Figs. 5–8)

Formica acervorum Fabricius, 1793, Hafniae: 358.
Leptothorax acervorum kamtschaticum Ruzsky, 1920: 78.
Mychothorax acervorum orientalis Kuznetsov–Ugamsky, 1928: 31.
Myrmica lacteipennis Zetterstedt, 1838: 452.
Leptothorax acervorum; Mayr, 1855: 436; Choi, 1986: 297; Kim and Choi, 1987: 125; Terayama *et al.*, 1992: 27; Choi and Bang, 1992b: 17; Choi and Bang, 1992c: 37; Choi and Bang, 1993: 321; Choi *et al.*, 1993: 346; Choi, 1996b: 9; Choi, 1996c: 47; Kim, 1996: 176; Choi, 1997a: 55.

Worker. Total length 3–3.5 mm. Head and gaster black; alitrunk, petiole and postpetiole reddish brown, their dorsum dark brown; legs brown. Antennae 11-segmented; scapes short, not reaching posterior margin of head in frontal view. Dorsum of pro- and mesonotum depressed in lateral view. Dorsum of propodeum weakly convex. Propodeal spines longer than wide in side view, with acute tips. Petiolar node high, triangular; anterior margin sloping



Figs. 5-8. *Leptothorax acervorum* (Fabricius): 5. Antenna, base; 6. Alitrunk, dorsal view; 7. Pronotum, lateral view; 8. Petiolar node, lateral view.

steeply forwards in lateral view; peduncle obscure.

Specimens examined. [JB] 3w, Mt. Jili-san, 15 VII 1985 (BM Choi).

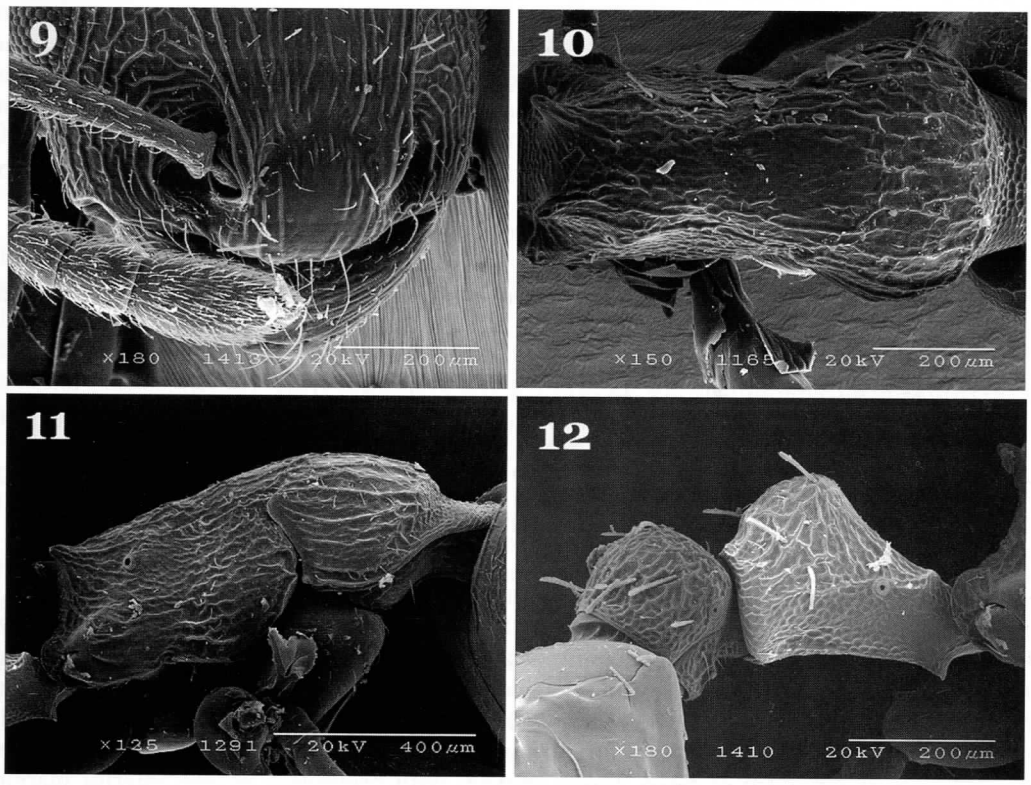
Distribution. Korea (North, Central, South and Is. Jeju-do) Russia, China, Japan, Eurasia and North America.

Remarks. This species may be diagnostically distinguished by the followings: propodeal spines longer than wide in lateral view, with acute tips, petiolar node high, triangular, anterior margin sloping steeply forwards in lateral view and peduncle obscure.

3. *Leptothorax congruus* Smith, 1874 호리가슴개미 (Figs. 9-12)

Leptothorax congruus Smith, 1874, Trans. Entomol. Soc. Lond. 1874: 406; Wheeler, 1906: 317; Wheeler and Wheeler, 1955: 24; Imai and Kubota, 1972: 197; Collingwood, 1976: 303; Choi, 1986: 297; Kim and Choi, 1987: 125; Kim *et al.*, 1989: 218; Choi and Park, 1991b: 83; Terayama *et al.*, 1992: 27; Choi and Bang, 1992a: 106; Choi and Bang, 1992c: 37; Kim *et al.*, 1992: 350; Choi and Bang, 1993: 321; Choi *et al.*, 1993: 346; Choi and Lee, 1995: 193; Choi, 1996a; 213; Choi, 1996b: 9; Choi, 1996c: 47; Kim, 1996: 176; Choi, 1997a: 55; Choi, 1997b: 126; Choi, 1998: 232; Choi and Park, 1998: 59.

Worker. Total length 2.5-3 mm. Body black to dark brown. Occipital margin of head with slightly convex, lateral sides almost straightened. Compound eyes situated nearer to anterior margin of head. Frons convex, with prominent before anterior margin. Antennal scapes short, not reaching posterior margin of head. Dorsal outline of alitrunk almost straight in lateral view. Propodeum with short, propodeal spines long in side view, with acute tips. Petiolar node



Figs. 9-12. *Leptothorax congruus* Smith: 9. Antenna, base; 10. Alitrunk, dorsal view; 11. Pronotum, lateral view; 12. Petiolar node, lateral view.

triangular, its dorsal margin angulated in lateral view. Gaster smooth and shining.

Specimens examined. [JB] 7w, Is. Seonyu-do, 22 IV 1993 (JR Bang); 2w, Gyeogpo, 2 VII 1992 (JY Bang); 1w, Gochang, 4 V 1995 (BM Choi); 7w, Gochang, 3 X 2002 (DP Lyu). [JN] 1w, Jangheung, 26 IV 2001 (DP Lyu); 19w, Is. Soan-do, 13 IX 1991 (BM Choi); 1w, Is. Daeheugsan-do, 7 VIII 1986 (BM Choi); 2w, Is. Daeheugsan-do, 4 IX 1991 (BM Choi). [GB] 1w, Yeongju, 26 VIII 1999 (DP Lyu). [GN] 1w, Haman, 20 VI 2002 (DP Lyu). [JJ] 1w, Seongpanag, 27 IX 2000 (DP Lyu).

Distribution. Korea (South and Is. Jeju-do) and Japan.

Remarks. It is easy to distinguish this species from others by the followings: dorsal outline of alitrunk almost straight in lateral view, propodeum with short, and propodeal spines long.

4. *Leptothorax koreanus* Teranish, 1940 진호리가슴개미

Leptothorax (*Nesomyrmex*) *koreanus* Teranish, 1940, Osaka: 16.

Leptothorax koreanus: Kim, 1963: 103; Kim, 1970: 480; Collingwood, 1976: 303; Kim and Kim, 1982: 104; Terayama *et al.*, 1992: 27; Choi *et al.*, 1993: 346; Kim *et al.*, 1993: 123; Kim *et al.*, 1994: 297; Choi, 1996b: 9; Choi, 1996c: 47; Kim, 1996: 176; Choi, 1997a: 55.

Worker. Total length 2-2.4 mm. Head and gaster black, alitrunk yellowish brown to dark brown. Antennae 11-segmented; scapes short, not reaching posterior margin of head and 3-segments clubs as long as the rest of funiculus. Mandibles trianglar, external border almost straight apical border with 5 teeth which gradually decrease in size from apex to base. Compound eyes moderately convex, situated a little before the middle of head in lateral view. Frotal carinae subparallele. Frontal area indistinct. Anterolateral corners of pronotum distinctly angled in dorsal view, with flattend dorsal surface. Both promesonotal and mesoepinotal sutures indistinct, in lateral view dorsal surface slightly arched. Propodeal spines rather long and acute as long as the base. Petiole as long as width, narrower in front than behind, in lateral view concaved anteroposteriorly and convexed superiorly, with a ventral process. Postpetiole transverse, boarder in front than behind, with rounded posterior borders.

Specimens examined. 1Q, 2w, Yeoju, 8 VI 2001 (DP Lyu).

Distribution. Korea (Central).

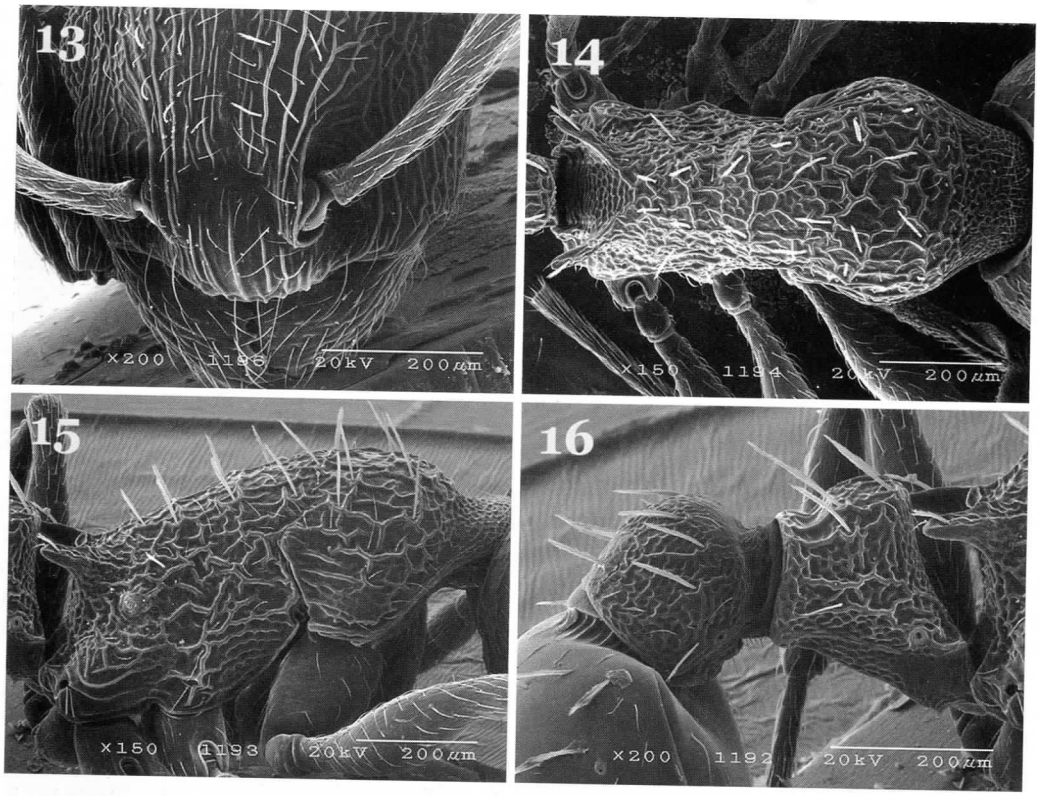
Remarks. It can be easily distinguished from others by the distinctly angulated pronotal humeri.

5. *Leptothorax nassonovi* Ruzsky, 1895 낫소노브호리가슴개미 (Figs. 13-16)

Leptothorax nassonovi Ruzsky, 1895, Tr. Obshch. Estest. Imp. Kazan. Univ. 28(5): 26; Kupyanskaya, 1990: 143; Kim, 1996: 176.

Leptothorax nassonovi: Ruzsky, 1905: 582; Emery, 1922: 255; Collingwood, 1976: 303; Collingwood, 1981: 27; Choi and Kim, 1987: 361; Terayama *et al.*, 1992: 27; Kim *et al.*, 1992: 350; Choi and Bang, 1993: 321; Choi *et al.*, 1993: 346; Radchenko, 1994: 155; Choi, 1996c: 47; Choi, 1997a: 55.

Worker. Body length 2.1-3.3 mm. Body brownish-yellow, dorsum of head yellowish-brown, gaster dark brown, almost black, legs, antennae, mandible and petiole bright-yellow. Head thin and longitudinal rugose, dorsum of alitrunk coarsely rugose, pedicel finely rugose. Dorsum of alitrunk with sparse short, underside with more dense distant hairs, legs with very short decumbent hairs. Head quadrangular, almost quadratic, occipital margin with sightly convex, angle slightly distinct, lateral sides almost straightened. Compound eyes situated nearer to anterior margin of head. Frons convex, with prominent before anterior margin. Mandible with 5 teeth, antennae with 3-segmented club. Antennal scape long, slightly not reached occipital margin, 1st segment of antennal funiculus thick and elongated, club segment



Figs. 13-16. *Leptothorax nassonovi* Ruzsky: 13. Antenna, base; 14. Alitrunk, dorsal view; 15. Pronotum, lateral view; 16. Petiolar node, lateral view.

longitudinal, the rest segments of antennal funiculus transverse. Alitrunk convex and short, with prominent in lateral view, without mesonotal seta. Spines of propodeum robust, acute, long, curved downward, equal to length of basal surface of propodeum or wider than it. Petiole with quite long cylindrical part, nodule convex, on apical acute or shortly rounded, its anterior part slightly concave, posterior shorter and subpetiolar process small, edge of border, or slightly convex, without distinct border.

Specimens examined. [GG] 13w, Gwangleung, 11 V 2001 (DP Lyu). [GW] 1w, Mt. Gyebang-san, 9 VI 2002 (DP Lyu); 7w, Mt. Chiag-san, 23 VI 1998 (DP Lyu).

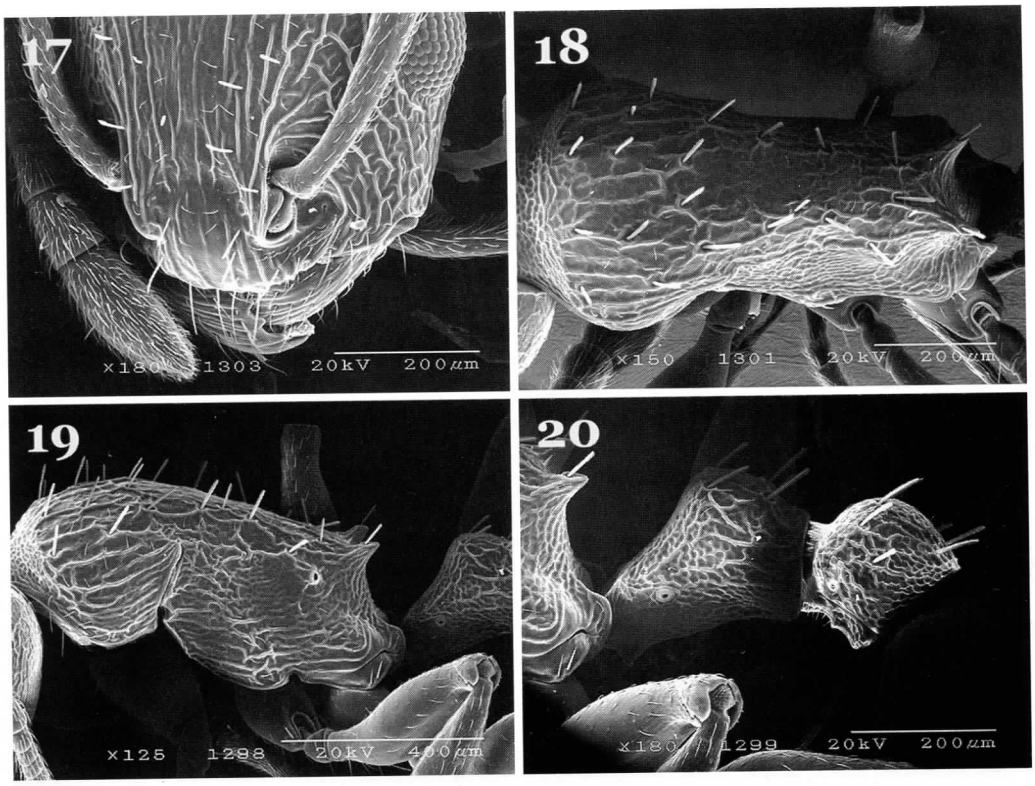
Distribution. Korea (North, Central), Russia

Remarks. It is similar to *L. tuberum*, but, based on comparison of the descriptions, differs in having dark color of head, petiole with quite long cylindrical part, nodule convex, and on apical plate acute or shortly rounded.

6. *Leptothorax serviculus* Ruzsky, 1902 검은수염호리가슴개미 (Figs. 17-20)

Leptothorax serviculus Ruzsky, 1902, Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere 17: 476; Collingwood, 1976: 304; Terayama *et al.*, 1992: 28; Choi and Bang, 1992b: 17; Choi *et al.*, 1993: 346; Choi, 1996b: 9; Choi, 1996c: 47; Kim, 1996: 177; Choi, 1997a: 55.

Worker. Body length 2.6-2.8 mm. Body dark-brown, mandible, antennae and appendages brown, gaster black. Frons with sparse longitudinal rugose, head from above thinly



Figs. 17-20. *Leptothorax serviculus* Ruzsky: 17. Antenna, base; 18. Alitrunk, dorsal view; 19. Pronotum, lateral view; 20. Petiolar node, lateral view.

longitudinal rugose, alitrunk reticulated-sculpture, nodule from above finely granulate sculpture, on curved area of propodeum and lateral petiole well distinct finely punctuated sculpture. Abdomen and legs smooth, shining. On body sparse, relatively long hairs. Head slightly elongated, almost quadratic, with almost straightened occipital margin and slightly convex laterally. Scape length not reached occipital margin, slightly curved, 2-6th segments of antennal funiculus transverse, 2nd segment of club somewhat elongated. Alitrunk elongated, narrowed posteriorly, dorsum slightly convex, almost smooth, with very shallow mesonotum deepening and distinct suture. Spines of propodeum more or less long, strong, somewhat curved, short. Pedicel short, thick cylindrical part, petiole not convex, from above narrowly rounded, without apparent area, sloped anteriorly, straightened posteriorly (or somewhat convex). Postpetiole from above almost rounded, slightly wider than petiole.

Specimens examined. [CB] 6w, Mt. Jangyong-san, 8 VII 1996 (BM Choi).

Distribution. Korea (Central)

Remarks. It is similar to *L. acervorum*, but, based on comparison of the descriptions, differs in having spines of propodeum more or less long, strong, somewhat curved, and short, and pedicel short, with thick cylindrical part.

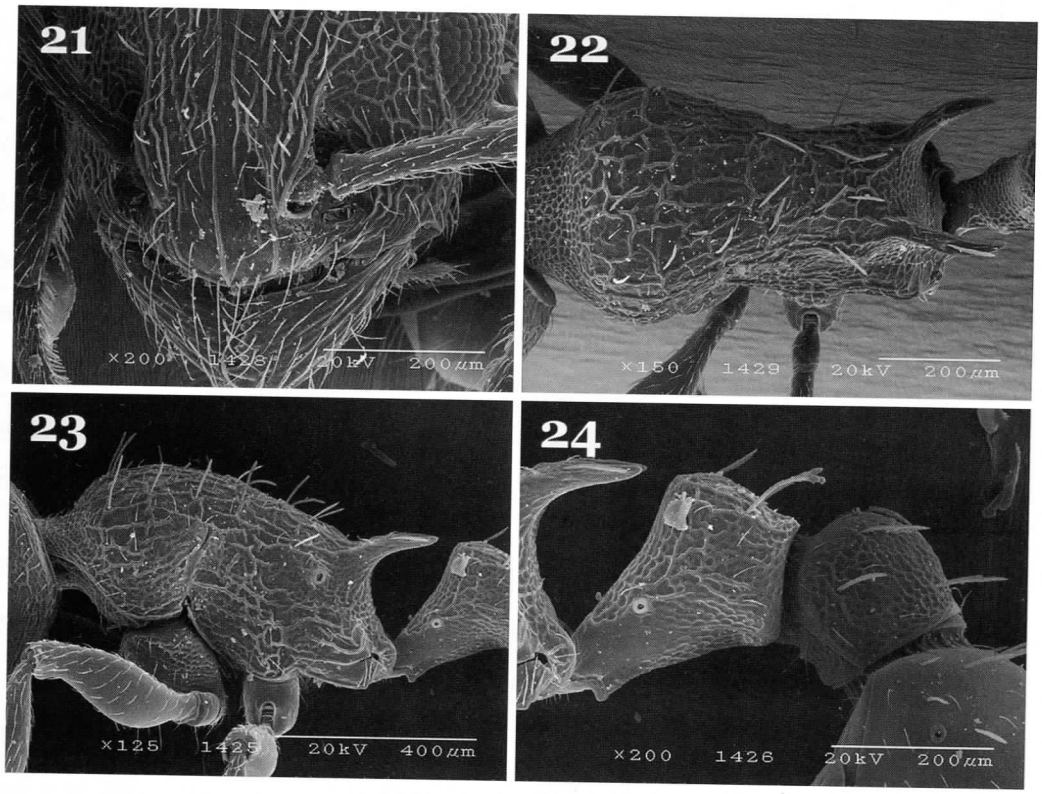
7. *Leptothorax spinosior* Forel, 1901 긴호리가슴개미 (Figs. 21-24)

Leptothorax congruus var. *spinosior* Forel, 1901, Ann. Soc. Entomol. Belg. 45: 371; Wheeler, 1906: 317; Teranishi, 1940: 4; Kim, 1963: 345; Imai, 1966: 119 Choi, 1996b: 9; Choi, 1998: 233.

Leptothorax spinosior: Choi, 1985: 411; Choi, 1986: 297; Choi and Kim, 1987: 360; Choi, 1988: 223; Kim *et al.*, 1989: 218; Terayama and Satoh, 1990: 532; Choi and Park, 1991a: 69; Choi and Park, 1991b: 83; Terayama *et al.*, 1992: 28; Choi and Bang, 1992a: 106; Choi and Bang, 1992b: 17; Choi and Bang, 1992c: 37; Kim *et al.*, 1992: 350; Choi and Bang, 1993: 321; Choi *et al.*, 1993: 346; Kim *et al.*, 1993: 123; Kim *et al.*, 1994: 298; Choi, 1996c: 47; Kim, 1996: 177; Choi, 1997a: 55; Choi, 1998: 217; Choi and Park, 1998: 60; Choi and Lee, 1999: 2; Choi and Park, 1999: 25.

Worker. Total length about 2 mm. Body black to dark brown. Head with slightly convex posterior margin in frontal view. Mandibles longitudinally rugulose. Antennae with 12 segments; antennal scapes almost reaching posterior margin of head in frontal view. Promesonotal dorsum weakly and evenly convex in lateral view. Metanotal groove incised dorsally. Dorsum of propodeum straight in lateral view; propodeal spines longand thin, directing upwardly. Petiolar node triangular in lateral view; anterior margin of node steeply sloping than posterior margin. Postpetiolar node as long as high, with convex dorsal margin. Gaster smooth and shining.

Specimens examined. [GG] 6Q, 14w, Mangweolsa, 7 VII 1999 (DP Lyu); 68w, Mt. Suli-san, 15 X 1999 (DP Lyu); 23w, Yeoju, 6 VI 2001 (DP Lyu). [GW] 1w, Gangleung, 25 V 2002 (DP Lyu); 1w, Pyeongchang, 23 IX 1998 (JY Choi); 21w, Mt. Chiag-san, 10 VII 1998 (DP Lyu). [CB] 3w, Mt. Weolag-san, 20 VI 2001 (DP Lyu). [JB] 4w, Muju, 25 V 1999 (DP Lyu). [JN] 5w, Is. Wan-do, 24 VI 1994 (DP Lyu); 3w, Is. Geogeum-do, 25 IV 1991 (BM Choi); 26w, Bigeum-do, 6 IX 1991 (BM Choi); 1w, Is. Soan-do, 13 IX 1991 (BM Choi). [GN] 4w,



Figs. 21-24. *Leptothorax spinosior* Forel: 21. Antenna, base; 22. Alitrunk, dorsal view; 23. Pronotum, lateral view; 24. Petiolar node, lateral view.

Uljin, 3 VIII 1992 (JY Bang); 1w, Sancheong, 17 V 2000 (DP Lyu). [JJ] 2w, Gwaneumsa, 28 VIII 1998 (DP Lyu); 2w, Seongpanag, 27 IX 2000 (DP Lyu); 5w, Seongpanag, 18 X 2002 (DP Lyu); 2w, Jungmun, 27 VIII 1998 (DP Lyu).

Distribution. Korea (North, Central, South, Is. Jeju-do) and Japan.

Remarks. It can be distinguished from other species by the petiolar node triangular in profile, with weakly convex posterior margin (almost straight in some specimens).

Two doubtable records from Korea

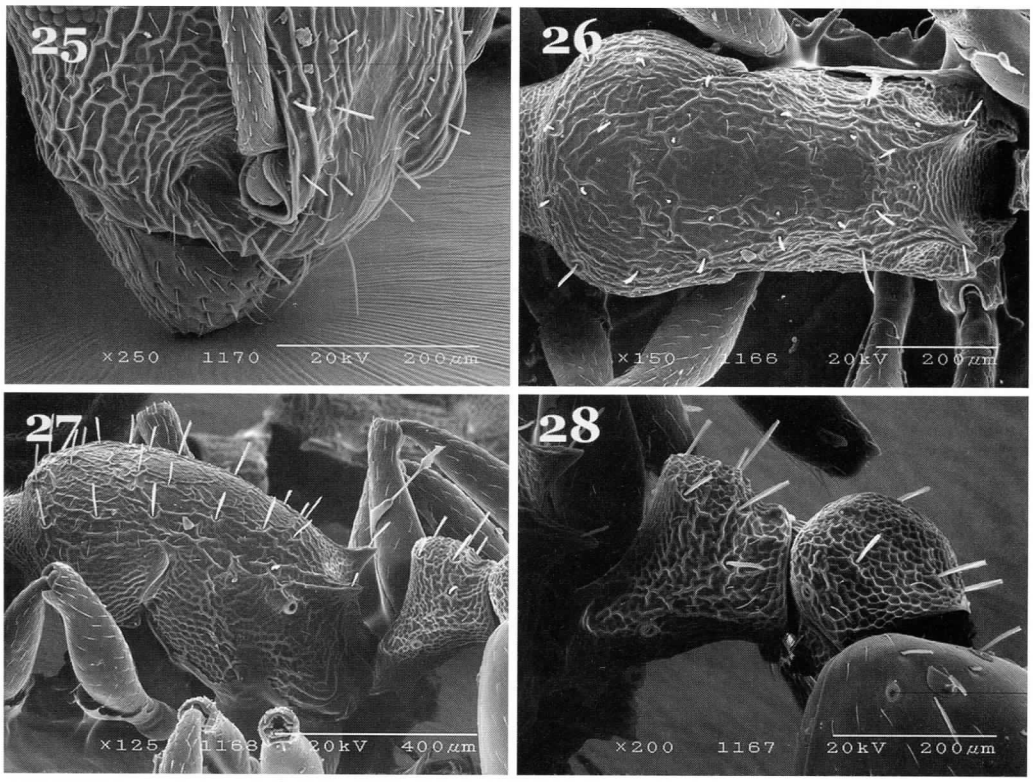
The following species are with questionable distribution records as has the first author not found any specimens preserved in Korea, especially, was not found through this study. Therefore, they may not occur in Korea.

I. *Leptothorax rabaudi* Bondroit, 1918 라보호리가슴개미

Leptothorax rabaudi Bondroit, 1918, Ann. Soc. Entomol. Fr. 87: 129; Bernard, 1967: 210; Collingwood, 1976: 304; Terayama *et al*. 1992: 28; Choi, 1996c: 47; Kim, 1996: 177.
Leptothorax affinis rabaudi: Menozzi, 1925: 28; Finzi, 1933: 164.
Leptothorax curvithorax Bondroit, 1918: 130.

Remarks. The distribution records of this species in Korea are questionable as I have not found any specimens preserved in Korea. This needs further investigation.

Distribution. France and subtropical area.



Figs. 25-28. *Leptothorax tuberum* (Fabricius) : 25. Antenna, base; 26. Alitrunk, dorsal view; 27. Pronotum, lateral view; 28. Petiolar node, lateral view.

II. *Leptothorax tuberum* (Fabricius, 1775) 산호리가슴개미 (Figs. 25–28)
Formica tuberum Fabricius, 1775, *Libraria Kortii*: 393.
Leptothorax tuberum: Collingwood, 1979: 75; Kim, 1996: 177.
Formica tuberosa Latreille, 1802: 259.
Leptothorax melanocephalus Emery, 1870: 197.
Leptothorax pratostepposus Arnol'di, 1977: 202.
Leptothorax tuberum acutinodis Arnol'di, 1977: 204.
Stenamma albipennis Curtis, 1854: 218.

Remarks. Common in South Norway, Sweden and Filand north to about latitude 62°, local in Denmark and in the coastal counties of S. England (Collingwood, 1979). The distribution records of this species in Korea are questionable as any specimens preserved in Korea was not found.

Distribution. In the mountains of Central Europe from Spain to the Caucasus and North Italy to Central Sweden.

Acknowledgements We would like to thank Mr. Lee, J.S. (National Institute of Agricultural Science and Technology, RDA, Suwon) and Dr. Hong, K. J. (National Plant Quarantine Service, Central Post-entry Quarantine Station, Suwon) for their technical help on SEM photographing.

REFERENCES

Arnold, G. 1948. New species of African Hymenoptera. No. 8. Occ. Papers of the Nat. Mus. Southern Rhodesia 2(14): 213–250.

Arnol'di, K.V. 1977b. New and little known species of ants of the genus *Leptothorax* Mayr (Hymenoptera: Forrnicidae). Rev. Entomol. URSS 61: 198–204.

Baroni Urbani, C. 1978. Materiali per una revisione dei *Leptothorax* neotropicali appartenenti al sottogenere *Macromischa* Roger, n. comb. (Hymenoptera: Formicidae). Entomol. Basil. 3: 395–618.

Bernard, F. 1967. Faune de l'Europe et du bassin Méditerranéen 3. Les fourmis (Hymenoptera: Formicidae) d'Europe occidentale et septentrionale. Paris: Masson. 411 pp.

Bolton, B. 1982. Afrotropical species of the myrmicine ant genera *Cardiocondyla, Leptothorax, Melissotarsus*, *Messor* and *Cataulacus* (Formicidae). Bull. Brit. Mus. (Nat. Hist.) Entomol. 45: 307–370.

Bolton, B. 1994. Identification guide to the ant genera of the world. Harvard University Press, Cambridge, MA. 222 pp.

Bolton, B. 1995. *A New General Catalogue of the Ants of the World*, 504 pp. Harvard University Press, Cambridge, Mass.

Bondroit, J. 1918. Les fourmis de France et de Belgique. Ann. Soc. Entomol. Fr. 87: 1–174.

Choi, B.M. 1985. Study on Distribution of Ants (Formicidae) from Korea (1). Formic fauna in Mt. Songni. Cheongju Tea. Coll. 22: 401–437.

Choi, B.M. 1986. Study on Distribution of Ants (Fonnicidae) from Korea (3). J. Won Kwang Univ. 16: 271–339.

Choi, B.M. 1988. Studies on the Distribution of Ants (Formicidae) in Korea (5). Ant Fauna in Is. Kanghwado. Cheongju Tea. Coll. 25: 217–231.

Choi, B.M. 1996a. Studies on the Distribution of Ants (Formicidae) in Korea (15). Ant Fauna Islands Ullngdo and Dokdo. Cheongju Tea. Coll. 33: 201–219.

Choi, B.M. 1996b. Distribution of Ants (Formicidae) in Korea (16). Ant Fauna from Chollabukdo. Korean J. Soil Zoology 1(1): 5–23.

Choi, B.M. 1996c. Distribution of Ants (Formicidae) in Korea (17). Distribution map of Province. Sci. Edu. Cheongju Nat'l. Univ. Edu. 17: 41–89.

Choi, B.M. 1997a. A Guide for the Identification of Korea Ants (I). Sci. Edu. Cheongju Nat'l. Univ. Edu. 18:

51-77.
Choi, B.M. 1997b. Distribution of Ants (Formicidae) in Korea (18). Ants Fauna in island Paekryongdo and Taech ngdo. Cheongju Tea. Coll. 34: 119-138.
Choi, B.M. 1998. Distribution of Ants (Formicidae) in Korea (19). Ant Fauna from Ch'ungch'ongbukdo Province. Cheongju Tea. Coll. 35: 213-266.
Choi, B.M. and J.R. Bang. 1992a. Studies on the Distribution of Ants (Formictdae) in Korea (9). Ant Fauna in Mt. Tokyu. Korean J. Appl. Entomol. 31(2): 101-112.
Choi, B.M. and J.R. Bang. 1992b. Studies on the Distribution of Ants (Formicidae) in Korea (10). Ant Distribution in Gangweondo. Sci. Edu. Cheogju Nat'l. Univ. Edu. 14: 12-30.
Choi, B.M. and J.R. Bang. 1992c. Studies on the Distribution of Ants (Formicidae) in Korea (11). Ant Distribution in Kyeongsangbukdo. Sci. Edu. Cheogju Nat'l. Univ. Edu. 14: 31-49.
Choi, B.M. and J.R. Bang. 1993. Studies on the Distribution of Ants (Formicidae) in Korea (12). The analysis of communities in 23 Islands. Cheongju Tea. Coll. 30: 317-330.
Choi, B.M. and C.H. Kim. 1987. Study on Distribution of Ants (Formicidae) from Korea (4)-Ant Fauna in Is. Hongdo and Is. Taehuksando. Cheongju Tea. Coll. 24: 357-370.
Choi, B.M., C.H. Kim, and J.R. Bang. 1993. Studies on the Distribution of Ants (Formicidae) in Korea (13). A Check List of Ants from Province (Do), with Taxonomic Notes. Cheongju Tea. Coll. 30: 339-363.
Choi, B.M. and H.S. Lee. 1999. Studies on the Distribution of Ants in Korea (21). Ant fauna in Kwanaksan. Korean J. Soil Zool. 4(1): 1-4.
Choi, B.M. and I.H. Lee. 1995. Studies on the Distribution of Ants (Formicidae) in Korea (14). Ants Fauna in Island. Soh ksando. Korean J. Appl. Entomol. 34(3): 191-197.
Choi, B.M. and E.C. Park. 1998. Studies on the Distribution of Ants (Formicidae) in Korea (20). Ant fauna in Mt. Chiaksan. Korean J. Soil Zool. 3(2): 58-62.
Choi, B.M. and E.C. Park. 1999. Studied on the Distribution of Ants (Formicidae) in Korea (23). Ant Fauna of Mt. Heksong. Sci. Edu. Cheogju Nat' l. Univ. Edu. 20: 21-26.
Choi, B.M. and K.S. Park. 1991a. Studies on the Distribution of Ants (Formicidae) in Korea (7). Ant Fauna in Kyeryongsan. Korean J. Appl. Entomol. 30(2): 65-79.
Choi, B.M. and K.S. Park. 1991b. Studies on the Distribution of Ants (Formicidae) in Korea (6). The Vegetation, the Species Composition and the Colony Density of Ants in Namsan, Seoul. Korean J. Appl. Entomol. 30(1): 80-85.
Collingwood, C.A. 1976. Ants (Hymenoptera: Formicidae) from North Korea. Ann. Hist.-Nat. Mus. Nat. Hung. 68: 295-309.
Collingwood, C.A. 1979. The Formicidae (Hymenoptera) of Fennoscandia and Denmark. Fauna Entomol. Scand. 8, Scandinavian Science press LTD., Denmark, 174 pp.
Collingwood, C.A. 1981. Ants (Hymenoptera: Formicidae) from Korea, 2. Folia Entomol. Hung. 42: 25-30.
Creighton, W.S. 1950. The ants of North America. Bull. Mus. Comp. Zool. Harvard Coll. 104:1-585, 57 pls.
Curtis, J. 1854. On the genus *Myrmica*, and other indigenous ants. Trans. Linn. Soc. London 21: 211-220.
Emery, C. 1869. Enumerazione dei Formicidi che rinvengonsi nei contorni di Napoli. Ann. Accad. Asp. Nat. (2)2: 1-26.
Emery, C. 1870. Studi mirmecologici. Boll. Soc. Entomol. Ital. 2: 193-201.
Emery, C. 1895. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. (Schluss.) Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere 8: 257-360.
Emery, C. 1896. Studi sulle formiche della fauna Neotropica. Boll. Soc. Entomol. Ital. 28: 33-107.
Emery, C. 1914. Intorno alla classificazione dei Myrmicinae. Rend. Sess. R. Accad. Sci. Ist. Bologna 18: 29-42.
Emery, C. 1917. Questions de nomenclature et synonymies relative a quelques genres et especes de formicides (Hym.). Bull. Soc. Entomol. France 1917: 94-97.
Emery, C. 1922. Hymenoptera, Fam. Formicidae, subfam. Myrmicinae. Genera Insectorum 174C: 207-397.
Fabricius, J.C. 1775. Systema entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. *Libraria Kortii*, Flensburgi et Lipsiae. 832pp.
Fabricius, J.C. 1793. Entomologia systematica emendata et aucta. Vol. 2. Christ. Gottl. Proft, Hafniae. 519pp.
Finzi, B. 1933. Raccolte entomologiche nell'Isola di Capraia fatte da C. Mancini e F. Capra (1927-1931). II. Formicidae. Mem. Soc. Entomol. Ital. 11: 162-165.
Forel, A. 1886. Especes nouvelles de fourmis Americaines. Ann. Soc. Entomol. Belg. Comptes-rendus Seances 30: xxxvii-xlix.

Forel, A. 1890. Fourmis de Tunisie et de l'Algerie orientale recoltees et decrites par Auguste Forel. Ann. Soc. Entomol. Belg. Comptes-rendus Seances 34: lxi-lxxvi.

Forel, A. 1893. Sur la classification de la famille des formicides, avec remarques synonymiques. Ann. Soc. Entomol. Belg. 37: 161-167.

Forel, A. 1899. Biologia Centrali-Americana; or, contributions to the knowledge of the fauna and flora of Mexico and Central America. Insecta. Hymenoptera. 3 (Formicidae). , London. 169 pp.

Forel, A. 1901. Varietes myrmecologiques. Ann. Soc. Entomol. Belg. 45: 334-382.

Forel, A. 1912. Descriptions provisoires de genres, sous-genres et especes de formicides des Indes orientales. Rev. Suisse Zool. 20: 761-774.

Forel, A. 1914. Formicides d'Afrique et d'Amerique nouveaux ou peu connus. Bull. Soc. Vaudoise Sci. Nat. 50: 211-288.

Forel, A. 1915. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia, 1910-1913. 2. Ameisen. Ark. Zool. 9(16): 1-119.

Hamann, H.H.F. and W. Klemm. 1967. Ergebnisse der zoologischen Nubien-Expedition 1962. Ann. Naturhistor. Mus. Wien 70: 411-421.

Imai, H.T. 1966. The chromosome observation techniques of ants and the chromosomes of Formicinae and Myrmicinae. Acta Hymenopterol. 2: 119-131.

Imai, H.T., C. Baroni Urbani, M. Kubota, G.P. Sharma, M.N. Narasimhanna, B.C. Das, A.K. Sharma, A. Sharma, G.B. Deodikar, V.G. Vaidya, and M.R. Rajasekarasetty. 1984. Karyological survey of Indian ants. Jpn. J. Genet. 59: 1-32.

Imai, H.T. and M. Kubota. 1972. Karyological studies of Japanese ants (Hymenoptera: Formicidae). 3. Karyotypes of nine species in Ponerinae, Formicinae, and Myrmicinae. Chromosoma 37: 193-200.

Kempf, W.W. 1959. A synopsis of the New World species belonging to the *Nesornyrmex-group* of the ant genus *Leptothorax* Mayr. Stud. Entomol. 2: 391-432.

Kim, B.J. 1996. Synonymic List and Distribution of Formicidae (Hymenoptera) in Korea. Entomol. Res. Bull. Suppl. (KEI): 169-196.

Kim, B.J., K.G.. Kim, J.Y. Park, and K.H. Lim. 1993. Systematic study of ants from Chejudo province. Korean J. Entomol. 23(3): 117-141.

Kim, B.J., D.P. Ryu, S.J. Park, and J.H. Kim. 1994. Systematic study on ants from coasts of Korean peninsula (Hym., Formicidae). Korean J. Entomol. 24 (4): 293-309.

Kim, C.H. and B.M. Choi. 1987. On the kinds of Ants (Hymenoptera Fonnicidae) and vertical Distribution in Mt. Chiri. Korean J. Plant Prot. 26(3): 123-132.

Kim, C.H., B.M. Choi, and J.R. Bang. 1992. Studies on the Distribution of Ants (Formicidae) in Korea (8). Ant Fauna in 10 Islands, Chllanamdo. Korean J. Appl. Entomol. 31(4): 345-359.

Kim, C.W. 1963. Hymenoptera of Korea. Thes. Hum. Sci. Korea Univ. 6: 343-345.

Kim, C.W. 1970. Illustrated encyclopedia of fauna and flora of Korea. 11 (3): 463-492.

Kim, C.W. and B.J. Kim. 1982. A taxonomical study of the subfamily Myrmicinae (Formicidae) from Korea. Ann. Rep. Bio. Res. Jeonbug Nat'l. Univ. 3: 95-110.

Kim, K.I., C.H. Kim, and B.M. Choi. 1989. The Ant Fauna of the Southern Shore in Kyeongsangnamdo, Korea. J. of Kyeongsang Nat'l. Univ. 28(2): 213-226.

Kupyanskaya, A.N. 1990. Ants of the Far East USSR. [In Russian.], Vladivostok: Akademiya Nauk SSSR, 258pp.

Kuznetsov-Ugamsky, N.N. 1928. [Ants of the South Ussuri area.] Zap. Vladivostok. Otd. Gos. Russ. Geog. Obshch. 1 (18): 1-47.

Latreille, P.A. 1802. Histoire naturelle des fourmis, et recueil de memoires et d'observations sur les abeilles, les araignees, les faucheurs, et autres insectes. Paris. 445pp.

Mann, W.M. 1920. Additions to the ant fauna of the West Indies and Central America. Bull. Am. Mus. Nat. Hist. 42: 403-439.

Mayr, G. 1855. Formicina austriaca. Beschreibung der bisher im oesterreichischen Kaiserstaate aufgefundenen Ameisen nebst Hinzufuegung jener in Deutschland, in der Schweiz und in Italien vorkommenden Ameisen. Verh. Zool.-Bot. Ver. Wien 5: 273-478.

Mayr, G. 1861. Die europäischen Formiciden. (Ameisen.) , Nach der analytichen Methode bearbeitet. Wien: C. Gerrolds Sohn, 80 pp.

Mayr, G. 1866. Myrmecologische Beiträge. Sitzungsber. K. Wiss. Math.-Naturwiss. Classe 53: 484-517.

Mayr, G. 1887. Sudamerikanische Formiciden. Verh. Zool.-Bot. Ges. Wien 37: 511-632.

Menozzi, C. 1925. Res Mutinenses. Formicidae (Hymenoptera). Atti Soc. Nat. Mat. Modena (6)3: 22–47.
Myrmecological Society of Japan (Ed.). 1992. A guide for the identification of Japanese ants (III). Myrmicinae and Supplement to Leptanillinae (Hymenoptera: Formicidae). [In Japanese.] Tokyo, 94 pp.
Nylander, W. 1856. Synopsis des formicides de France et d'Algerie. Ann. Sci. Nat. (Zool.) (4)5: 51–109.
Pagliano, G. and P. Scaramozzino. 1990. Elenco dei generi di Hymenoptera del mundo. Mem. Soc. Entomol. Ital. 68: 1–210.
Radchenko, A.G. 1994. Key to ants of the genus *Leptothorax* (Hymenoptera: Formicidae) of central and southern Palaearctic. Zool. Zh. 73(7–8): 146–158.
Roger, J. 1863. Die neu aufgefuhrten Gattungen und Arten meines Formiciden–Verzeichnisses, nebst Erganzung einiger fruher gegebenen Beschreibungen. Berl. Entomol. Z. 7: 131–214.
Ruzsky, M. 1895. Faunistic investigations in eastern Russia 1. Contribution to the ant fauna of east Russia. 2. Zoological excursion in the Orenberg region in 1894. [In Russian.] Tr. Obshch. Estest. Imp. Kazansk. Univ. 28 (5): 1–32.
Ruzsky, M. 1902. Neue Ameisen aus Russland. Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere 17: 469–484.
Ruzsky, M. 1904. On ants from Archangel province. [In Russian.] Zap. Imp. Rus. Geogr. Obshch. Obshch.Geogr. 41: 287–294.
Ruzsky, M. 1905. The ants of Russia. (Formicariae Imperii Rossici.). Systematics, geography and data on the biology of Russian ants. Part I. [In Russian.] Tr. Obshch. Estest. Imp. Kazansk. Univ. 38: 1–800.
Ruzsky, M. 1920. Ants of Kamchatka. [In Russian.] Izv. Inst. Issled. Sibiri (Tomsk) 2: 76–80.
Santschi, F. 1912. Fourmis d'Afrique et de Madagascar. Ann. Soc. Entomol. Belgique 56: 150–167.
Santschi, F. 1930. Formicides de l'Angola. Resultats de la Mission scientifique suisse en Angola (1928–1929). Rev. Suisse Zool. 37: 53–81.
Shindo, M. 1980. Notes on colony formation of Cardiocondyla sp.. J. BTAT, 16: 19–23.
Smith, F. 1859. Catalogue of hymenopterous insects collected by Mr. A.R. Wallace at the Islands of Aru and Key. J. Proc. Linn. Soc. London Zool. 3: 132–158.
Smith, F. 1874. Descriptions of new species of Tenthredinidae, Ichneumonidae, Chrysididae, Formicidae, etc. of Japan. Trans. Entomol. Soc. Lond. (4)7: 373–409.
Smith, M.R. 1950. On the status of Leptothorax Mayr and some of its subgenera. Psyche 57: 29–30.
Teranishi, C. 1940. Works of Cho Teranishi. Memorial Volume. Osaka: Kansai Entomol. Soc., 312+ (posthumous section) 95 pp.
Terayama, M., B.M. Choi, and C.H. Kim. 1992. A Check List of Ants from Korea with Taxonomic Notes. Bull. Toho Gakuen 7: 19–54.
Terayama, M. and T. Satoh. 1990. Taxonomic notes on two Japanese species of Formicidae (Hymenoptera). Jap. J. Entomol. 58: 532.
Wheeler, G.C. and J. Wheeler. 1955. The ant larvae of the myrmicine tribe Leptothoracini. Ann. Entomol. Soc. Amer. 48: 17–29.
Wheeler, G.C. and J. Wheeler. 1973. The ant larvae of six tribes: second supplement (Hymenoptera: Formicidae: Myrmicinae). J. Georgia Entomol. Soc. 8: 27–39.
Wheeler, W.M. 1906. The ants of Japan. Bull. Am. Mus. Nat. Hist. 22: 301–328.
Wheeler, W.M. 1910. Three new genera of myrmicine ants from tropical America. Bull. Amer. Mus. Nat. Hist. 28: 259–265.
Wheeler, W.M. 1935. Myrmecological notes. Psyche 42: 68–72.
Wilson, E.O. and R.W. Taylor. 1967. The ants of Polynesia (Hymenoptera: Formicidae). Pac. Ins. 14: 1–109.
Zetterstedt, J.W. 1838. Insecta Lapponica. Sectio secunda. Hymenoptera: 317–475.

(Received: September 28, 2003, Accepted: November 26, 2003)