

REVIEW

Review of the Genus *Myrmica* in Korea (Hymenoptera: Formicidae)

Dong-Pyeo Lyu*

Department of Forestry, Sangji University, Wonju-shi, Gangwon-do 220-702, Korea

Abstract The paper contains a taxonomic review of 12 species of the genus *Myrmica* occurring in Korea. The following species are under discussion: *M. angulinodis* Ruzsky, *M. carinata* Kupyanskaya, *M. hyungokae* Elmes, *M. jessensis* Forel, *M. kasczenkoi* Ruzsky, *M. kotokui* Forel, *M. koreana* Elmes, *M. kurokii* Forel, *M. lobicornis* Nylander, *M. ruginodis* Nylander, *M. silvestrii* Wheeler, *M. sulcinodis* Nylander. Twelve species of the genus *Myrmica* are recognized from Korea, these are revised and a key to their identification is provided. Five species, *M. cadusa*, *M. incurvata*, *M. saphoshikovi*, *M. scabrinodis*, and *M. yoshiokai* are questionable to be distributed in Korea, as I have not found any specimens preserved in Korea. The SEM photo and illustrations of the worker of each species are provided.

Key words Myrmicinae, *M. carinata*, *M. kurokii*, *M. koreana*, *M. sulcinodis*

Introduction

Genus *Myrmica* species are largely predaceous, however, in several species a certain degree of trophobiosis with aphids, including subterranean forms, was observed when blossoms or other nectar producing plant organs are visited. The main fields of action are the ground surface and the top of litter layer but a number of species will forage additionally in the field and lower bush layers. The colonies are not populous in most of the species, containing few hundred to 1,000 (rarely 10,000) workers (Seifert, 1988). Accepting the redefinition of the genus by Bolton (1988), the pectinate tibial spurs on the middle and hind legs become less important as a diagnostic character of the genus because they show a graded sequence of reduction from well pectinate to simple spinous condition or even absent. This genus contains about 200 species in the world.

*Corresponding author.

E-mail: myrmicinae@sangji.ac.kr

Tel: +82-33-730-0526; Fax: +82-33-738-7680

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Systematics

Genus *Myrmica* Latreille, 1804

Myrmica Latreille, 1804, *Nouv. Dict. Hist. Nat.* 24: 179. Type species: *Formica rubra* Linnaeus, 1758: 580.

Sifolinia Emery, 1907, *Rend. Sess. R. Accad. Sci. Ist. Bologna* 11: 49. Type species: *Sifolinia laurae* Emery, 1907: 49.

Sommimyrmica Menozzi, 1925, *Atti. Soc. Nat. Mat. Modena* 55: 25. Type species: *Sommimyrmica symbiotica* Menozzi, 1925: 25.

Sybiomyrmica Arnol'di, 1930, *Zool. Anz.* 91: 267. Type species: *Sybiomyrmica karavajevi* Arnol'di, 1930: 267.

Paramyrmica Cole, 1957, *J. Tenn. Acad. Sci.* 32: 37. Type species: *Paramyrmica colax* Cole, 1957: 37.

Dodcecemyrmica Arnol'di, 1968, *Zool. Zh.* 47: 1803. Type species: *Myrmica arnoldii* Dlussky, 1963: 194.

Worker diagnosis. Worker caste monomorphic. Body with cuticle thick and with an armoured appearance; usually cuticle strongly sculptured. Head almost oval in frontal view, with narrow transverse posterior border; occipital carinae low. Mandibles broadly subtriangular and strongly dentate, with 7-10 teeth which gradually decrease in size from apex to base. Palp formula 6:4. Frons broad posteriorly, broadly inserted between anterior portions of frontal lobes. Frons with longitudinal rugulae interrupted by posterior border of frons and not continuous with rugulae of rest of head; Median portion of frons broad and shallowly biconvex, with a somewhat swollen appearance. Anterolateral portions in front of antennal insertions sometimes forming ridge or carina. Well defined frontal triangle present immediately behind posteromedian clypeal margin. Frontal lobes often prominent. Frontal carinae and antennal scrobes absent. Frontal carinae short, covering antennal insertions, and diverging at level of compound eyes. Antennae 12-segmented; scape usually curved or bent at base;

funiculus enlarged apical forming an indistinct 3 or 4-segment club; last 3 segments shorter than remainder of funiculus. Compound eyes prominent, convex; located on side at or slightly anterior to midlength of head (excluding mandibles). Alitrunk elongate and low; promesonotal suture indistinct dorsally; promesonotal region slightly raised; metanotal groove more or less distinct; propodeum with a pair of long spines posterodorsally. Propodeal spiracle low on side (just above or near junction with metapleuron), usually slightly behind propodeal midlength. Metapleural lobes present and usually broadly angular. Petiole with a short anterior peduncle and an anteroventral tooth or process. Tibial spurs on mid and hind legs usually pectinate but showing all stages of reduction to absent. Sting strong and simple, never spatulate and always lacking appendages.

Queen: General form of head like that of worker, with larger compound eyes and distinct ocelli. Pronotum overhung by mesoscutum; mesonotum somewhat flat dorsally; notauli absent, parapsidal furrows present on mesonotum; mesoscutellum partly overhanging metanotum; propodeal spines well developed as in worker. Epimeral lobe absent. Remainder of body, including legs, petiole, postpetiole and gaster like those of worker.

Male: Head subglobose, with low but distinct occipital carina. Mandibles developed, subtriangular in form, with dentate masticatory margin. Palp formula 5:3. Frons large, convex in the middle; anterior margin rounded; posterior margin produced between frontal carinae. Frontal carinae short, partly covering antennal insertions situated close to posterior margin of frons. Frontal area distinct and triangular in form; concave between frontal carinae and median posterior border of frons. Antenna 13-segmented; scape usually long, extending beyond posterior border of head; funiculus thick, incrassate. Compound eyes large and prominent; inner margin not concave. Pronotum smaller, overhung by mesoscutum; both notauli and parapsidal furrows distinctly impressed; mesonotum flat dorsally; mesoscutellum overhanging metanotum; propodeum without long spines, but with angulated posterodorsal corners. Epimeral lobe absent. Ventral processes reduced to small tooth on both meso and metasterna. Legs as in worker, but pectination of tibial spurs more distinct. Petiole and postpetiole large and distinct with rounded nodes. Genitalia retractile; basal ring broader than long; paramere with distinct gonocoxal arm and rounded apex; inner wall of paramere bearing distinct oblique ridge ventrolaterally; volsella with large lobate digitus and small lamellate cuspis; aedeagal plate subtriangular with rounded apex in lateral view.

Key to species of *Myrmica* in Korea, based on

workers.

1. Antennal scrobes present *carinata* **Kupyanskaya**
- Antennal scrobes absent 2
2. Antennal scape curved weakly and gradually, without angle at base 3
- Antennal scape more curved, either without angle at base or angulated, with vertical tooth or lobe 4
3. Dorsum of alitrunk sculptured with strong rugae, many of which are longitudinal; posterior border of mesonotal dorsum raised rugae *kotokui* **Forel**
- Dorsum of alitrunk sculptured with densely rugulose; mesopropodeal depression weak, petiole without anterior cylindrical part and massive *kurokii* **Forel**
4. Propodeal spines relatively short, shorter basal plate of propodeum and equal to distance between basal spines 5
- Propodeal spines long, longer basal plate of propodeum than distance between their bases 11
5. Petiole on sides with coarse rugulose as on alitrunk, anterior surface steep, with apical area forming rectangle *sulcinodis* **Nylander**
- Petiole with granulose sculpturation and dull rugulose, less coarse than on dorsum of alitrunk, anterior surface forming obtuse angle with apical area 6
6. Petiole in lateral view not angulated, anterior surface slightly concave and transient into upper surface at blunt angle; apical area not distinct, convex, and weakly slanted posteriorly 7
- Antennal scape sharply curved, with angle or acute edge on vertical part; petiole with strongly posteriorly slanted area, and sharply angulated in lateral view 8
7. Petiole in lateral view sharply angulated; straight longitudinal rugules on head developed mainly on frons; occiput looplike sculpturation predominant *saphoshikovi* **Ruzsky**
- Petiole sharply angulated, anterior surface forming acute with distinct, strongly posteriorly slanted apical area; propodeal spines widened near base, directed upward often curved inward *angulinodis* **Ruzsky**
8. Petiole with straight anterior surface, apical area strongly slanted posteriorly making node in lateral view subtriangle *incurvata* **Collingwood**
- Petiole of different shape 9
9. Frons narrow; petiole with shorter anterior cylindrical part, anterior surface steep, concave, and forming with dorsal surface sharp, acute angle; apical area distinct, slightly slanted pos-

- teriorly *lobicornis* Nylander
- Frons wider, shape of petiole different; antennal scape with tooth or small lobe 10
 - 10. Petiole high, anterior surface not steep, concave, apex broadly rounded, and convex; propodeal spines long, acute, widening near the base; mesonotal depression deep *jessensis* Forel
 - Petiole low, anterior surface weakly concave and forming upper surface blunt angle; propodeal spines slender, not widened near the base; mesonotal depression weak *silvestrii* Wheeler - 11. Propodeal spines long laterally directed upward and curved inward; antennal scape strongly curved near the base without tooth or lobe *kasczenkoi* Ruzsky
 - Propodeal spines long and slender, laterally directed upward; antennal scape strongly curved near the base with tooth or lobe 12 - 12. In lateral view petiole slightly shorter from apex of ventral tooth to postpetiole than it is high; anterior surface weakly concave, dorsal surface weakly convex; meet at a slightly rounded right angle *yoshiokai* Weber
 - Petiole in lateral view massive with truncate dorsal area and abrupt step in caudal slop of node down to junction with postpetiole .. 13 - 13. Petiole with sharp rugulose, propodeal spines long; antennal scape and tibial spurs short, sparse, erect setae *ruginodis* Nylander
 - Petiole with distinct peduncate in lateral view, propodeal spines long; antennal scape and tibial

spurs large 14

- 14. The petiole relatively short and high, with a very short and thick peduncle; in lateral view, the petiolar node distinctly truncate, the dorsal surface gradually slopes backwards and the anterior and posterior surfaces appear almost vertical *hyungokae* Elmes

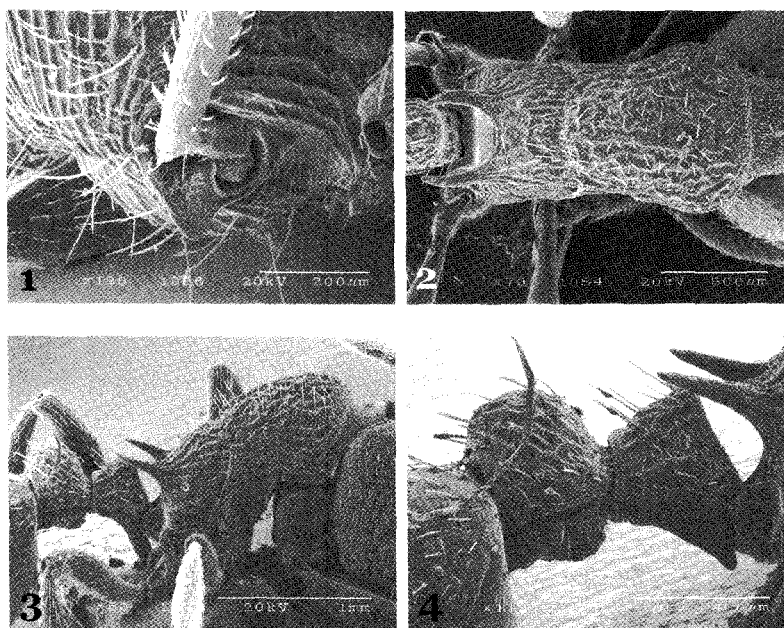
 - The petiole relatively low with a short but distinct peduncle in lateral view, anterior surface of petiole distinctly concave, forming a rounded right angle at the dorsal surface, posterodorsal surface a shallow, but somewhat angulated arch *koreana* Elmes

1. *Myrmica angulinodis* Ruzsky 1905 각뿔개미 (Figs. 1-4)

Myrmica scabrinodis angulinodis Ruzsky, 1905, Tr. Obshch. Estestvoispyt. Imp. Kazan. Univ. 38: 689.

Myrmica angulinodis: Collingwood, 1962, Entomol. Tidskr. 83: 217; Collingwood, 1976: 302; Tera-yama *et al.*, 1992: 24; Kim, 1996: 179.

Worker. Total length 4-4.5 mm. Body reddish and yellowish brown; head dark brown and appendage yellowish brown. Antennal scape extending posterior portion of head; funiculus apical enlarged forming an indistinct club with 4 segments. Anterior margin of frons gently smooth and coarse. Reticular side of head well developed, narrow and opaque. Alitrunk more coarse and longitudinal striae; petiole severely rugose. Propodeal spines more or less short and extending posterodorsally; slope of dorsal area be-



Figs. 1-4. *Myrmica angulinodis* Ruzsky: 1. Portion of antennal insertion; 2. Alitrunk, dorsal view; 3. Alitrunk, lateral view; 4. Petiolar node, lateral view.

tween propodeal spines flatten and shining. Petiole very short and with anterior angle in dorsal view. In lateral view, anterior of petiole steeply and slightly concave, posterior slightly slope and nearly straight and little convex. Dorsum of postpetiole with longitudinal striae and small sculpture.

Specimens examined. 2w, Chitinskaya, Russia, 26 VIII 1971 (A Kupyanskaya).

Distribution. Korea (North), Siberia, Japan.

Remarks. Collingwood (1976) recorded this species from Korea, but no specimen was available. The record by Kim (1996) is probably based on the citation from Collingwood's record. The description above followed Ruzsky (1905) and the specimens examined.

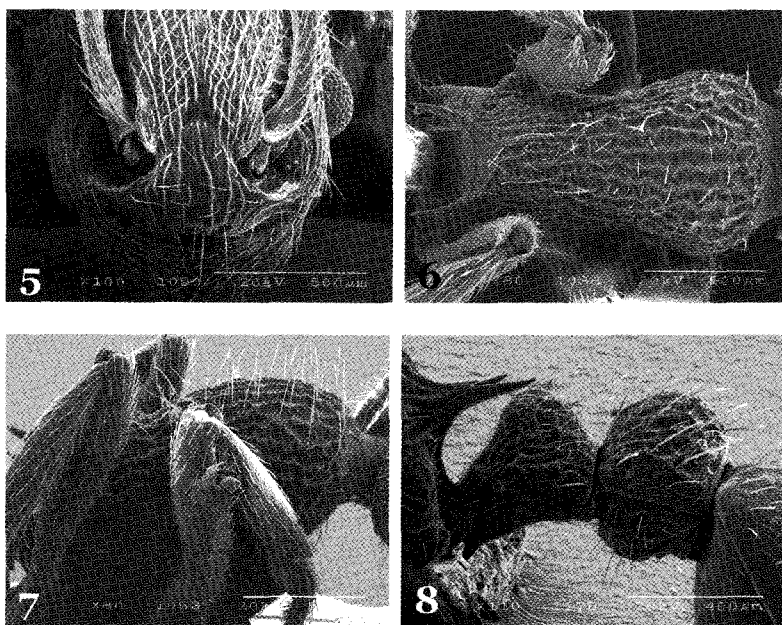
2. *Myrmica carinata* Kupyanskaya 1990 나도항아리 풀개미 (Figs. 5-8)

Myrmica carinata Kupyanskaya, 1990, Ants of the Far Eastern USSR: 114.

Worker. Total length 3.5-4 mm. Body from bright brown to dark brown; mouthpart, antennae and legs dark brown, abdomen dark brown. Body with fine dense punctures, especially distinct on head and stalk of petiole, postpetiole matted, fine rugose. Head slightly elongate. Forehead and frons with shallow longitudinal rugose, other part of body with reticulated sculpture. Forehead wide, frontal roller narrow, short (not far from antennal scrobe), frontal area strongly widened downwards. Antennal scrobe somewhat elongate, beans-like. Antennal scape reached occipital margin, at base sharply curved, on pliable part slightly

thinner than base, to apex gradually widened. Frons with keel, intermittent at margin of antennal scrobe, same as specimen of genus *Tetramorium*. Antennal scape at base with dark border from lateral (from side). Frontal area matted, longitudinal rugose, with eroded border, reclinated plate of propodeum smooth, at apical part (between spines) thinly and densely transverse rugose. On scape and legs - sparse reclinated semi-erected hairs. Mesonotal depression slight, dorsal plate of pronotum slightly convex (almost flat) and make with back of alitrunk fixed profile. Spines of propodeum moderately length (about same length as base plate of propodeum or slightly shorter than it), sharply thinned, on apex sharp, irregular at side. In lateral view petiole wide, from above flat, rounded, smoothly at lateral side. Postpetiole (from above) almost rounded, with long, about same its width. Gaster smooth and shining.

Specimens examined. [GG] 14w, Mt. Dobong-san, 7 VII 1999 (DP Lyu); 1w, Mt. Cheonma-san, 3 VII 2002 (DP Lyu); 125w, Mt. Suli-san, 21 VII 1999 (DP Lyu). [GW] 16w, Mt. Seolag-san, 25 VIII 1984 (BM Choi); 16w, Mt. Seolag-san, 8 VI 1985 (BM Choi); 10w, Undulyeong, 18 V 2002 (DP Lyu); 1w, Mt. Chiag-san, 10 VII 1998 (BM Choi); 6w, Mt. Chiag-san, 21 VII 1998 (DP Lyu). [CB] 9w, Mt. Weolag-san, 18 VII 1985 (BM Choi); 1w, Mt. Weolag-san, 21 VI 2002 (DP Lyu); 1w, Mt. Sobaeg-san, 14 V 1985 (BM Choi); 2w, Mt. Janglyong-san, 9 VII 1996 (BM Choi); 7w, Mt. Sogli-san, 8 VI 1985 (BM Choi). [JN] 17w, Is. Geogeum-do, 25 IV 1991 (BM Choi). [JJ] 3w, Mt. Hanla-san, 27 VIII 1998 (DP Lyu).



Figs. 5-8. *Myrmica carinata* Kupyanskaya: 5. Portion of antennal insertion; 6. Alitrunk, dorsal view; 7. Alitrunk, lateral view; 8. Petiolar node, lateral view.

Distribution. Korea (Central, South and Is. Jeju), Japan and Russia.

Remarks. This is reported for the first time from Korea.

3. *Myrmica hyungokae* Elmes, Radchenko and Kim 2001 형옥뿔개미

Myrmica hyungokae Elmes *et al.*, 2001, Korean J. Biol. Sci. 5: 109.

Worker. Head slightly longer than width, with feebly convex or even subparallel sides, slightly concave occipital margin, and rounded occipital corners; anterior clypeal margin shallowly but distinctly notched medially; frons narrow, frontal carinae strongly curved and margin of antennal sockets with rugae. Antennal scapes relatively short and sharply bent at their bases, with small vertical tooth-like lobes. In lateral view, dorsum of alitrunk more or less regular but somewhat flattened arch; metanotal groove very shallow; promesonotal suture indistinct; metapleural lobes angulated posterodorsally. Propodeal spines relatively long straight and sharp, with moderately broad bases, projecting backwards and upwards at an angle $<45^\circ$ to horizontal. Petiole relatively short and high, with a very short and thick peduncle. In lateral view, petiolar node distinctly truncate, dorsal surface gradually slopes backwards and anterior and posterior surfaces appear almost vertical. Postpetiole relatively massive, wide and distinctly higher than long; in lateral view, dorsum forms a broadly rounded arch with its apex posterior of mid point, and ventral surface distinctly prominent.

Tibial spurs present and well developed on middle and hind tibiae but feebly pectinate. Anterior and central parts of frons and clypeus longitudinally rugose; remainder of head dorsum coarsely reticulate; frontal area longitudinally striated; mandibles finely longitudinally rugulose. Surfaces between rugae finely but distinctly punctured, appearing dull; frons more or less shiny. Median portions of alitrunk coarse longitudinal sinuous rugae and dorsum coarsely reticulate; entire petiole coarsely reticulate; postpetiole longitudinally rugose. Surfaces between rugae on alitrunk and petiole finely punctured; gaster smooth and shiny. Occipital and lateral margins of head and entire alitrunk with abundant thick, straight, erect to suberect hairs; legs with numerous subdecumbent hairs, scapes with suberect hairs. Body reddish brown; sides of alitrunk reddish brown and appendages dark yellow (Elmes *et al.*, 2001).

Specimens examined. None.

Distribution. Korea (South).

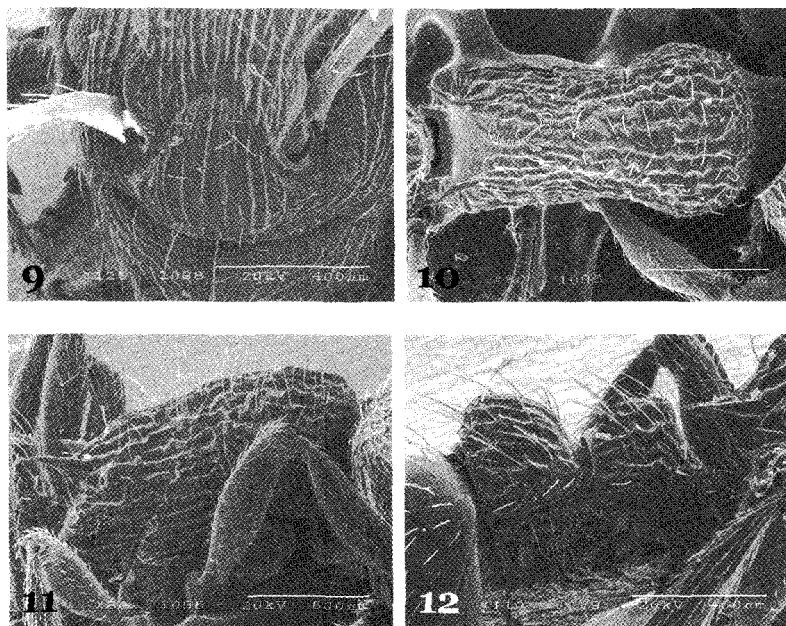
Remarks. Elmes *et al.* (2001) described this species from Korea, but no specimen was found through this study.

4. *Myrmica jessensis* Forel 1901 곰배자루뿔개미 (Figs. 9-12)

Myrmica lobicornis var. *jessensis* Forel, 1901b, Ann. Soc. Entomol. Belg. 45: 371.

Myrmica lobicornis jessensis Weber, 1948, Ann. Entomol. Soc. Am. 41: 286.

Myrmica jessensis: Collingwood, 1976, Ann. Hist.-Nat. Mus. Natl. Hung. 68: 302; Kupyanskaya, 1986:



Figs. 9-12. *Myrmica jessensis* Forel: 9. Portion of antennal insertion; 10. Alitrunk, dorsal view; 11. Alitrunk, lateral view; 12. Petiolar node, lateral view.

85; Kim and Choi, 1987: 125; Kim, 1996: 180. *Myrmica jessensis*: Kupyanskaya, 1990: 110; Tera-
yama *et al.*, 1992: 25; Choi and Bang, 1992a: 106;
Choi and Bang, 1992b: 38; Choi and Bang, 1993:
321; Choi *et al.*, 1993: 342; Choi *et al.*, 1993: 47;
Choi, 1996a: 9; Choi, 1996b: 46; Choi, 1997: 54;
Choi, 1998: 231.

Worker. Total length 4.0-5.4 mm. Alitrunk and legs yellowish brown, gaster dark brown. Dorsum of head with longitudinal rugose, antennal socket with slightly distinct concentric rugose. Forehead portion with slightly longitudinal rugose. Dorsal and lateral portions of alitrunk with rough longitudinal rugose, inclined surface of propodeum smooth, with slightly distinct transverse line between propodeal spines. Dorsum of petiole slightly rugose. Head obviously elongate with slightly convex at lateral sides, gradually sloped to occipital angle and straightened to occipital margin. Compound eyes slightly oval, its large diameter almost same as length of cheek. Frons convex and anterior margin of frons somewhat emarginated. Antennal scape extending occipital margin, curved at base under straightened angle, with small transverse semi-circular lobe on curved portion. Dorsal line of alitrunk smoothly curved; metanotal groove shallow, but always distinct. Basal surface of propodeum slightly convex, posterior inclined plate. Spines of propodeum at base wide, length of spine usually equal to distance between apexes. Petiole with more or less developed cylindrical part, its anterior plate smoothly inclined and gradually, without acute angle,

intermittent toward dorsal rounded surface. Postpetiole relatively long, its length about equal to width, from above almost rounded.

Specimens examined. [GW] 14w, Mt. Odae-san, 24 V 2002 (DP Lyu).

Distribution. Korea (Central), Russia and Japan.

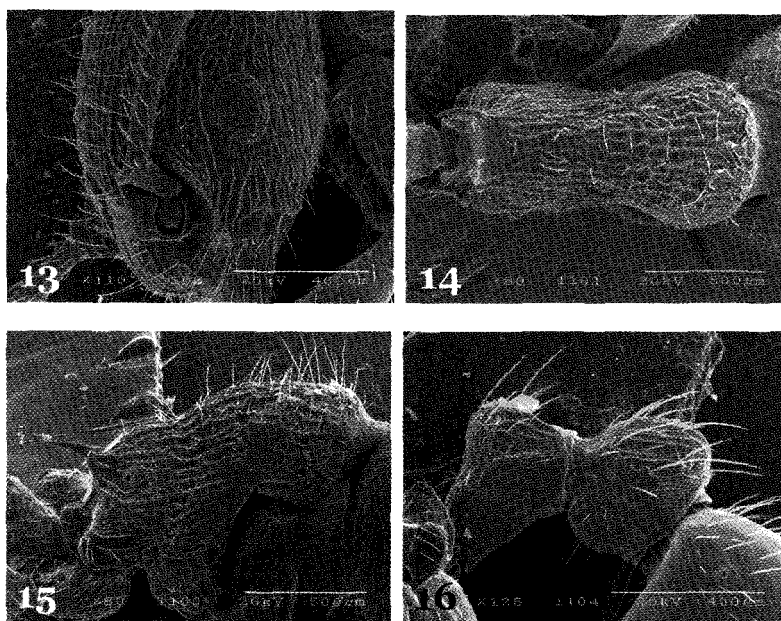
Remarks. It nests under stones or directly in the soil of open grasslands or bare lands, and can be abundant on dry riverbeds. Morisita (1945) reported that this is distributed from 300 to 1700m above sea level in the mountain.

5. *Myrmica kasczenkoi* Ruzsky 1905 카스코젠코펠개미 (Figs. 13-16)

Myrmica scabrinodis kasczenkoi Ruzsky, 1905, Tr. Obshch. Estestvoispyt. Imp. Kazan. Univ. 38(4-6): 702; Collingwood, 1976: 302.

Myrmica kasczenkoi: Pisarski, 1969: 296; Dlussky and Pisarski, 1970: 85; Collingwood, 1976: 302; Tera-
yama *et al.*, 1992: 25; Kim, 1996: 179.

Worker. Body length 3.6-4.0 mm. Body color reddish brown, antennae and legs darkish yellow, head, gaster, upper side of alitrunk and petiole darkish brown. Head slightly elongate. Dorsum of head and lateral sides of alitrunk with longitudinal rugose, other part of head and alitrunk with rough reticulate sculpture. Antennal scape curved under obtuse angle, with small obtuse angle on pliable part, rudimentary narrow longitudinal lobe. Alitrunk with slight mesonotal depression, propodeum flat. Propodeal spines short, shorter basal plate of propodeum and equal to distance



Figs. 13-16. *Myrmica kasczenkoi* Ruzsky: 13. Portion of antennal insertion; 14. Alitrunk, dorsal view; 15. Alitrunk, lateral view; 16. Petiolar node, lateral view.

between basal spines, moderately thin, gradually thinned toward apex, directed to dorsum paralleled each other. Propodeum with longitudinal rugose at dorsal part, inclined plane of propodeum shining, with thin transverse line at dorsal part. Petiole almost without cylindrical part, nodule triangular, same as worker of *M. forcipata*, but anterior plate concave, and posterior convex, apex acute. Postpetiole short and high in lateral view. Stalk of gaster from above finely rugose.

Specimens examined. 1w, Chita, Russia, 17 VII 1990 (A Radzenko).

Distribution. Korea (North), Russia and Mongolia.

Remarks. Since I could not find any Korean specimens, only a Russian specimen was examined. Kim's citation (1996) is probably based on Collingwood's record. Sexual forms are recorded in July - August. They are usually found in Siberia, at pine forest and on old cutting wood area, settled at ground of hill of small size (Dmitrienko and Petrenko, 1976).

6. *Myrmica koreana* Elmes, Radchenko, and Kim 2001 엽상자루뿔개미(Figs. 17-20)

Myrmica koreana Elmes *et al.*, 2001, Korean J. Biol. Sci. 5: 108.

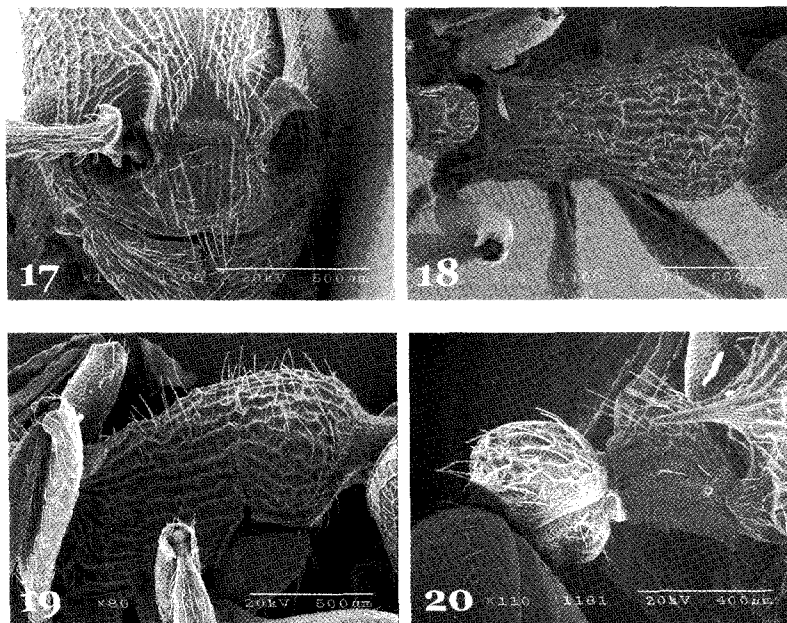
Worker. Head slightly longer than broad, with strongly convex sides, and very broadly rounded occipital corners; anterior clypeal margin shallowly but distinctly notched medially. Frons quite narrow; frontal carinae strongly curved and margin of antennal sockets with rugae. Antennal scapes relatively long

and sharply bent at their bases, with a small vertical lobe. In lateral view, dorsum of alitrunk somewhat flattened arch; metalpleural groove very shallow; promesonotal suture indistinct; metapleural lobes angulated posterodorsally. Propodeal spines long, straight and sharp projecting backwards and upwards at just less than 45° to horizontal. Petiole relatively low with a short but distinct peduncle in lateral view, anterior surface of petiole distinctly concave, forming a rounded right angle at dorsal surface, posterodorsal surface a shallow, but somewhat angulated arch. Postpetiole subglobular, relatively low and wide; in lateral view, ventral surface of postpetiole backwards and almost straight, posterodorsal surfaces slightly angulated arch with apex close to posterior. Hind and middle tibiae large pectinate spurs. Mandibles finely longitudinally rugulose; frons and clypeus longitudinally rugose, with central part of frons having reduced rugosity; remainder of head dorsum coarsely reticulated; surfaces between rugae finely punctured but more or less shiny; frontal area and clypeus smooth and shiny. Dorsum of alitrunk with coarse, sinuous rugosity and straight longitudinal rugae on its sides; petiole and postpetiole with coarse longitudinal rugae. Surfaces of alitrunk and petiole finely punctured but shiny; gaster smooth and shiny. Body yellowish; alitrunk and waist testaceous yellow, and the head and gaster yellowish red (Elmes *et al.*, 2001).

Specimens examined. [CB] 4w, Mt. Sogli-san, 19 VIII 1984 (BM Choi).

Distribution. Korea (North, Central and South).

Remarks. Elmes *et al.* (2001) described this species



Figs. 17-20. *Myrmica koreana* Elmes *et al.*: 17. Portion of antennal insertion; 18. Alitrunk, dorsal view; 19. Alitrunk, lateral view; 20. Petiolar node, lateral view.

from Korea, only the specimens I examined were identified by Dr. Kupyanskaya, Far Eastern Branch of the Institute of Biology and Soil Sciences, Russian Academy of Science, Vladivostok, Russia, in 2002.

7. *Myrmica kotokui* Forel 1911 코토쿠뿔개미(Figs. 21-24)

Myrmica rubra kotokui Forel, 1911, Sitzungsber. Math.-Phys. Kl. K. Bayer. Akad. Wiss. Münch. 1911: 267.

Myrmica kotokui: Collingwood, 1976: 300; Choi and Bang, 1992b: 38; Choi and Bang, 1993: 321; Choi, 1996a: 9; Choi, 1996b: 46; Kim, 1996: 179; Kim *et al.*, 1996: 122; Choi, 1997: 54; Choi, 1998: 231. *Myrmica ruginodis kotokui*: Onoyama, 1989: 131; Terayama *et al.*, 1992: 25; Choi *et al.*, 1993: 47.

Worker. Total length 4 - 5.5 mm. Body brown to dark brown; legs yellowish brown. Antennal scape curved gently near antennal base. Anterior margin of frons convex at the middle; rugae on frons projecting anteriorly so as to appear as denticles. Dorsum of alitrunk sculptured with strong rugae, many of which are longitudinal. Posterior border of mesonotal dorsum raised rugae. Propodeal spines usually long. Anterior base of 1st gastral tergite with longitudinal rugae.

Specimens examined. [JN] 1 worker, Is. Wan-do, 24 VI 1994 (DP Lyu).

Distribution. Korea and Japan.

Remarks. This species is similar to the European *M. ruginodis* Nylander. Onoyama (1989) suggested

that it might be a subspecies of *ruginodis*. A detailed comparison is required in the future, with *ruginodis* specimens from the Russian Far East.

8. *Myrmica kurokii* Forel 1907 쿠로키뿔개미(Figs. 25-28)

Myrmica rubra kurokii Forel, 1907, Jahrb. Hamburg. Wiss. Anstalten. 24: 18.

Myrmica kurokii var. *sontica* Santschi, 1937, Bull. Ann. Soc. Entomol. Belg. 77: 367; Weber, 1947: 470.

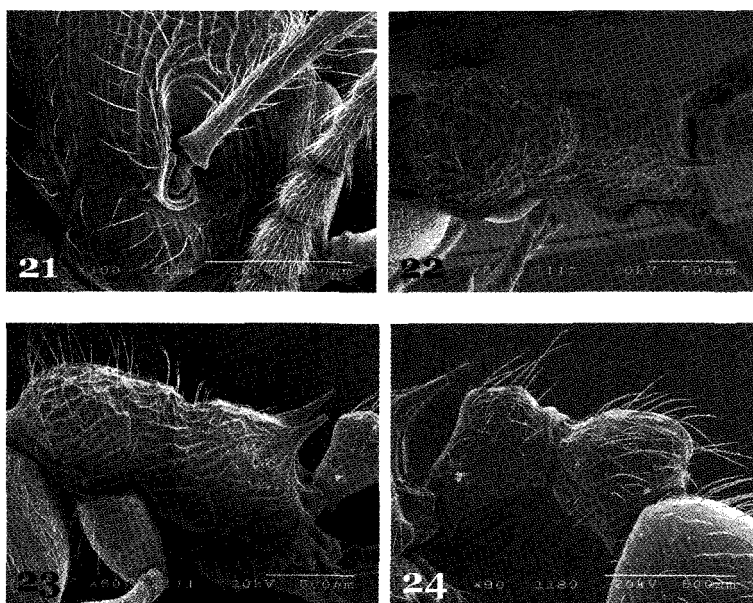
Myrmica kurokii st. *tipuna* Santschi, 1937: 367.

Myrmica kurokii: Emery, 1908: 171; Weber, 1947: 469; Collingwood, 1976: 301; Kim, 1982: 13; Terayama *et al.*, 1992: 25; Choi *et al.*, 1993: 343; Choi *et al.*, 1993: 47; Choi, 1996a: 9; Choi, 1996b: 46; Kim, 1996: 179; Choi, 1997: 54; Choi, 1998: 231.

Worker. Total length 4.5-5.5 mm. Body bicolored: head, gaster and legs black, alitrunk reddish brown. Antennal scape curved rather strongly near base. Anterior margin of frons convex at the center, without projecting denticles. Pronotal dorsum with fine, irregular rugae; mesonotal dorsum with fine rugae, which are in many cases transverse; smooth, shining areas small. Petiolar node short; posterodorsal border in lateral view curving rather gently posteriorly. Subpetiolar process developed, anteriorly projecting.

Specimens examined. [JJ] 12w, Mt. Hanla-san, 24 IV 1984 (BM Choi).

Distribution. Korea (Is. Jeju), Russia and Japan.



Figs. 21-24. *Myrmica kotokui* Forel: 21. Portion of antennal insertion; 22. Alitrunk, dorsal view; 23. Alitrunk, lateral view; 24. Petiolar node, lateral view.

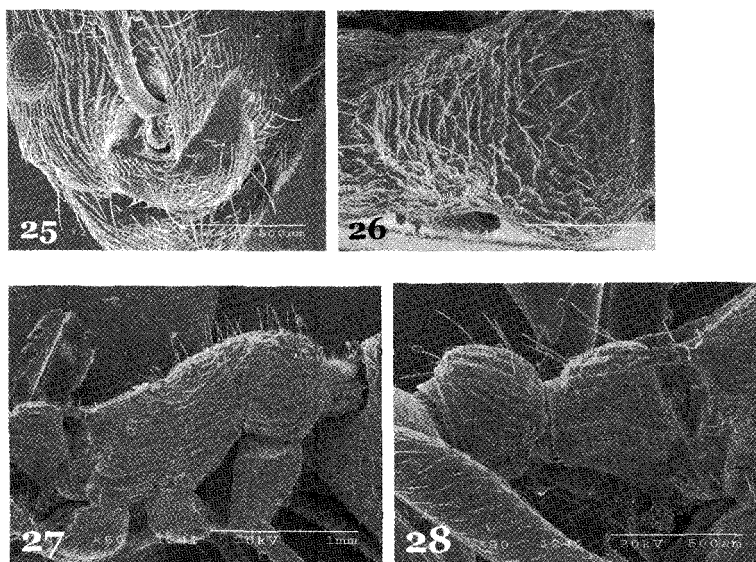
Remarks. This species nests in grasslands, under stones at rocky sites, and near the roots of trees. Its altitudinal distribution is the most extreme among Korean *Myrmica* species.

9. *Myrmica lobicornis* Nylander 1846 곰뿔개미(Figs. 29-32)

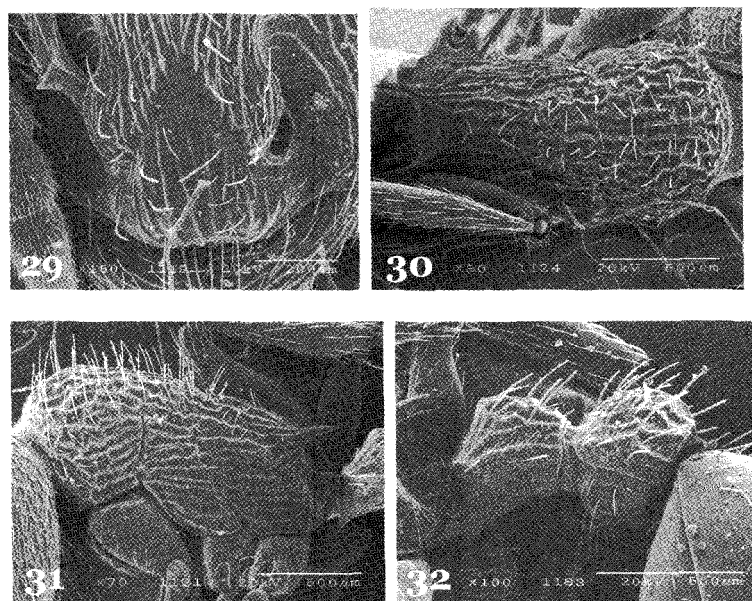
Myrmica lobicornis Nylander, 1846, Acta Soc. Sci. Fenn. 2: 932, pl. 18, figs 32, 33(w.q.); Saunders, 1880: 216; André, 1883: 318; Nasonov, 1889: 35;

Forel, 1892: 315; Donisthorpe, 1915: 134; Forel, 1915: 28; Emery, 1916: 120; Bondroit, 1918: 105; Finzi, 1926: 106; Störcke, 1927: 76; Santschi, 1931: 347; Collingwood, 1958: 73; Bernard, 1967: 122; Kutter, 1977: 66; Arnol'di and Dlussky, 1978: 534; Collingwood, 1979: 51; Choi, 1985: 411; Choi *et al.* 1985: 445; Choi, 1986: 297; Choi, 1988: 222; Seifert, 1988: 38; Atanassov and Dlussky, 1992: 101; Choi and Park, 1998: 59.

Myrmica rubra lobicornis; Forel, 1874: 76; Wheeler,



Figs. 25-28. *Myrmica kurokii* Forel: 25. Portion of antennal insertion; 26. Alitrunk, dorsal view; 27. Alitrunk, lateral view; 28. Petiolar node, lateral view.



Figs. 29-32. *Myrmica lobicornis* Nylander: 29. Portion of antennal insertion; 30. Alitrunk, dorsal view; 31. Alitrunk, lateral view; 32. Petiolar node, lateral view.

1906: 316; Kim, 1996: 179.

Myrmica scabrinodis lobicornis; Mayr, 1886: 451; Ruzsky, 1905: 693; Emery, 1908: 179.

Worker. Total length 4-5 mm. Sculptures of head and alitrunk normally coarse and with anastomose. A tooth-like to spooned-shaped transverse process at bend of antennal scape with variable size. Frons about 1/3 head width. Frontal triangle smooth and shining. Concavity below propodeal spines in lateral view smaller than lateral propodeal lobe. Mesopropodeal impression well-developed. Petiole typically high and wide, with anterior and dorsal surfaces meeting at a right angle. Postpetiole broadly oval from above.

Specimens examined. 2w, Buryatia, Russia, 1 VIII 1977 (A Kupyanskaya).

Distribution. Korea, Japan, Paleartics from Portugal to Siberia, Europe.

Remarks. Kim (1996) recorded this species from Korea, but I was unable to examine any specimen from Korea.

10. *Myrmica ruginodis* Nylander 1846 빗개미 (Figs. 33-36)

Myrmica ruginodis Nylander, 1846, Acta Soc. Sci. Fenn. 2: 928, pl. 18, figs. 5, 30 (w.q.m.); Saunders, 1880: 214; André, 1883: 317; Nasonov, 1889: 33; Forel, 1892: 315; Bondroit, 1912: 351; Donisthorpe, 1915: 115; Bondroit, 1918: 103; Santschi, 1919: 244; Müller, 1923: 41; Finzi, 1926: 85; Stitz, 1939: 83; Novák and Sadil, 1941: 76; Holgersen, 1942: 8; Collingwood, 1958: 68; Bernard, 1967:

120; Collingwood and Yarrow, 1969: 56; Collingwood, 1976: 300; Kutter, 1977: 67; Arnol'di and Dlussky, 1978: 530; Collingwood, 1979: 53; Ogata *et al.*, 1985: 160; Choi, 1985: 411; Choi *et al.*, 1985: 445; Choi, 1986: 297; Choi and Kim, 1987: 359; Kim and Choi, 1987: 125; Seifert, 1988: 6; Atanassov and Dlussky, 1992: 86; Choi and Bang, 1992a: 106; Choi *et al.*, 1993: 343; Kim, 1996: 179; Choi and Park, 1998: 59; Choi and Park, 1999: 25.

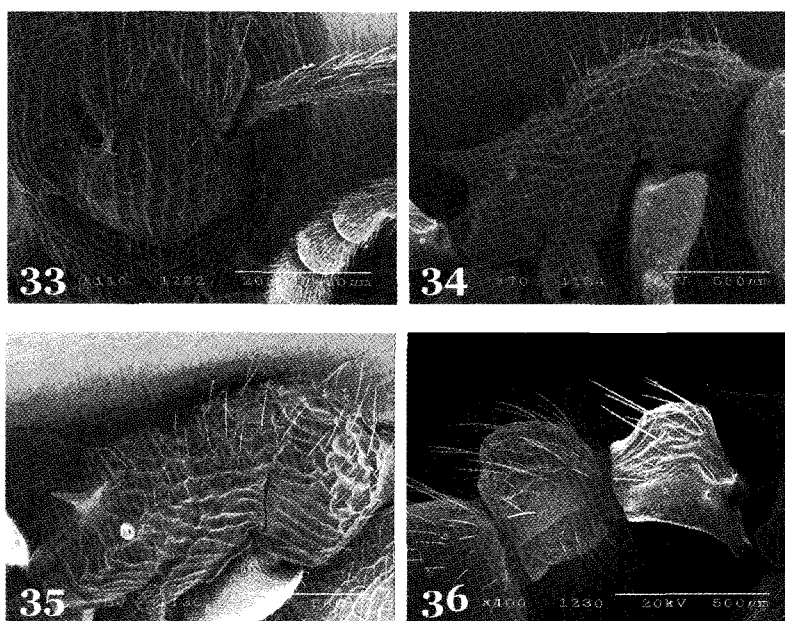
Myrmica rubra var. *ruginodis* Forel, 1874: 76; Ruzsky, 1904: 288; Bondroit, 1910: 498; Forel, 1915: 28; Menozzi, 1918: 82; Karavaiev, 1927: 258.

Worker. Total length 4-6 mm. Body pale to dark reddish brown. Head and alitrunk with well-developed longitudinal rugosity. Frontal triangle smooth and shining. Antennal scapes long and slender, gently and obliquely curved near their base. Propodeal spines long and robust; area between their bases laterally striate, frontal triangle smooth and shining. Petiole in lateral view massive with truncate dorsal area and abrupt step in caudal slop of node down to junction with postpetiole. In fraspinal area transversely striate; petiolar and postpetiolar nodes normally rugose. Gaster smooth and shining.

Specimens examined. 2w, Baikal, Russia, 5 VIII 1977 (A Kupyanskaya).

Distribution. Korea and throughout the Northern Paleartics from Western Europe to Japan, Italy to North Cape.

Remarks. The workers of *M. ruginodis* are easily



Figs. 33-36. *Myrmica ruginodis* Nylander: 33. Portion of antennal insertion; 34. Alitrunk, lateral view; 35. Alitrunk, dorsal view; 36. Petiolar node, lateral view.

distinguished from those of *M. rubra* by petiolar shape and much longer spines of propodeum. Kim (1996) recorded this species from Korea, but no specimen was found in this study. The description above is based on the Russian specimens of the same species I examined. Kim's citation (1996) is probably based on Collingwood (1976)'s record.

11. *Myrmica silvestrii* Wheeler 1928 주름뿔개미 (Figs. 37-40)

Myrmica ruginodis var. *silvestrii* Wheeler, 1928, Boll. Lab. Zool. Gen. Agar. R. Sc. Super. Agric. 22: 100.

Myrmica rubra var. *silvestrii* Weber, 1947, Ann. Entomol. Soc. Am. 40: 451.

Myrmica silvestrii: Collingwood, 1976: 300; Kim, 1996: 180.

Worker. Total length 4.5-5.5 mm. Body dark brown, posterior portion of head, petiole, postpetiole and most of gaster nearly black; propodeal spines and legs brownish yellow; mandibles, antennae, ventral portion of petiole and tip of gaster somewhat dark and more reddish. Head larger and broader; antennal scapes a little more slender at base. Propodeal spines straight and distinctly shorter. Surface impression of alitrunk coarser, rugae on pronotum being thicker, more round and very irregular and vermiculate. Space between propodeal spines smooth and shining. Petiole much more strongly longitudinally rugose and postpetiole subopque.

Specimens examined. 1w, Mt. Fugi, Japan, 27 VII 1981 (U Kubota).

Distribution. Korea, Europe, Russia and Japan.

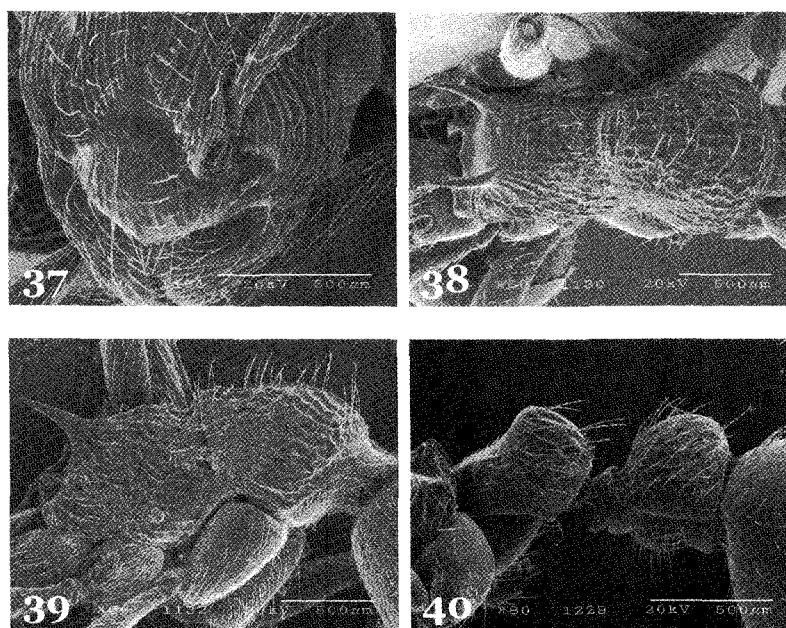
Remarks. Kim (1996) recorded this species from Korea, but no specimen was found through this study. Kim's citation is probably based on Collingwood (1976)'s record. The description above is based on Wheeler (1928).

12. *Myrmica sulcinodis* Nylander 1846 어리뿔개미 (Figs. 41-44)

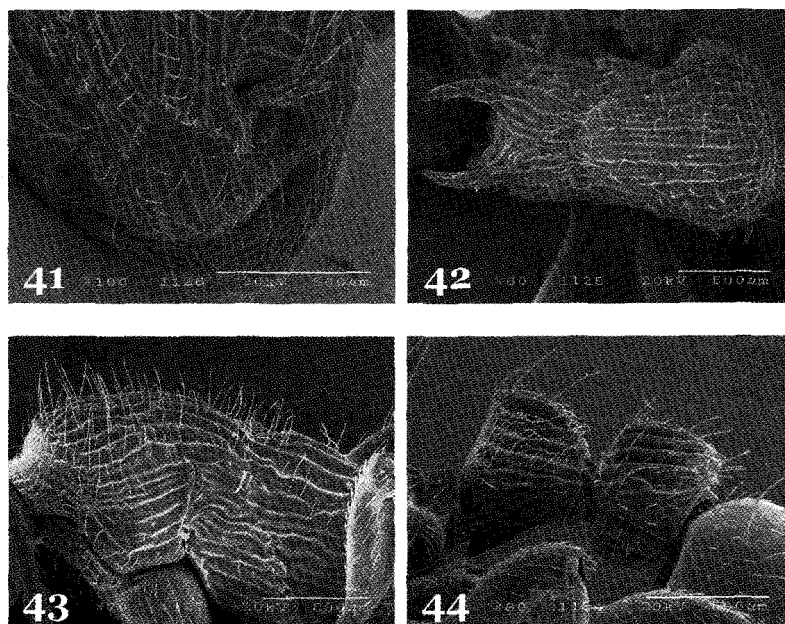
Myrmica sulcinodis Nylander, 1846, Acta Soc. Sci. Fenn. 2: 934; Mayr, 1855: 409; Teranishi, 1940: 4; Collingwood, 1976: 301; Kim and Choi, 1987: 125; Choi, 1996a: 9; Choi, 1996b: 46; Kim, 1996: 180; Choi, 1998: 231.

Myrmica rubra sulcinodis: Forel, 1874: 76; Wheeler, 1908: 406.

Worker. Total length 4-6 mm. Body reddish brown with head and gaster dark brown. Strongly longitudinally rugulose, frontal triangle longitudinally striates. Antennal scapes sharply curved near base but not really angled, with sharp edge running along outside of bend down to base and without lamellar lobe or teeth. Frontal triangle entirely or at least in part with well-developed longitudinal striae. Alitrunk with very coarse, regularly longitudinal rugosity with lacks transverse connections or reticular structures. Propodeal spines long, stout and blunt, frequently subparallel and incurved in dorsal view. Mesopropodeal furrow shallow. Petiole high with long anterior face, with upper surface forming straight or obtuse angle, apical area distinct and not slanted posteriorly, never truncate.



Figs. 37-40. *Myrmica silvestrii* Wheeler: 37. Portion of antennal insertion; 38. Alitrunk, dorsal view; 39. Alitrunk, lateral view; 40. Petiolar node, lateral view.



Figs. 41-44. *Myrmica sulcinodis* Nylander: 41. Portion of antennal insertion; 42. Alitrunk, dorsal view; 43. Alitrunk, lateral view; 44. Petiolar node, lateral view.

Specimens examined. 3w, Buryatia, Russia, 27 VII 1977 (A Kupyanskaya).

Distribution. Korea, Japan, and Palearctics from Portugal to Siberia.

Remarks. Kim (1996) recorded this species from Korea, but no specimen was found in this study. Kim's citation is probably based on Collingwood (1976)'s record, and the description above is based on Collingwood (1979).

Five doubtful records from Korea

Various reports on ant survey in South Korea have been presented with insufficient description of most species, and some misidentifications and incorrect names were found. The distribution of following species is questionable as I have not found any specimens preserved in Korea through this study, therefore, this needs further though investigation to collect the specimens of *Myrmica* in Korea.

1. *Myrmica cadusa* Kim and Park 1997 항아리뿔개미
Myrmica cadusa Kim and Park. 1997: 425.

Remarks. It is very similar to and is probably a synonym of *Myrmica excelsa* Kupyanskaya (Elmes *et al.* 2001: 107.). No specimens were found through this study.

Distribution. Korea (?).

2. *Myrmica incurvata* Collingwood 1976

Myrmica incurvata Collingwood, 1976, Ann. Hist.-Nat. Mus. Natl. Hung. 68: 301; Terayama *et al.* 1992: 25; Kim, 1996: 179; Choi and Park, 1998: 59; Choi and Park, 1999: 25.

Remarks. This was recorded by Collingwood (1976) only from North Korea. It is thought that the record from North Korea by Kim (1996) cited from Collingwood's record. However, I have not found any specimen from South Korea.

Distribution. Korea (North) and Russia.

3. *Myrmica saphoshikovi* Ruzsky 1904

Myrmica lobicornis r. *saphoshikovi* Ruzsky, 1904a, Izv. Imp. Tomsk. Univ. 30: 3; Teranish, 1940: 15. *Myrmica scabrinodis saphoshikovi* Ruzsky, 1905, Tr. Obshch. Estestvoispyt. Imp. Kazan. Univ. 38(4-6): 701; Emery, 1908: 180; Kim, 1982: 14; Kim, 1996: 180.

Myrmica saphoshikovi: Pisarski, 1969: 296.

Remarks. Kim (1982) recorded this species from Korea, but no specimen was found through this study. It needs further investigation.

Distribution. Korea (?) and Japan.

4. *Myrmica scabrinodis* Nylander 1846

Myrmica scabrinodis Nylander, 1846, Acta Soc. Sci. Fenn. 2: 930; Wheeler and Wheeler, 1953: 119; Hauschteck, 1965: 325.

Myrmica scabrinodis pilosiscapus: Kutter, 1977: 69; Collingwood, 1979: 55; Seifert, 1988: 27; Casevitz-Weulersse, 1990: 137.

Myrmica scabrinodis rugulosoides: Bernard, 1967: 116; Banert and Pisarski, 1972: 350; Collingwood, 1979: 55; Seifert, 1984: 1.

Myrmica rubra scabrinodis Forel, 1874: 76; Emery and Forel, 1879: 460; Emery, 1895a: 313; Forel, 1904: 374; Wheeler, 1908: 406.

Myrmica scabrinodis: Saunders, 1880: 215; Nasonov, 1889: 36; Emery, 1898: 126; Emery, 1908: 174; Bondroit, 1912: 351; Donisthorpe, 1915: 125; Forel, 1915: 29; Karavaiev, 1916: 504; Emery, 1916: 120; Wheeler, 1917: 504; Bondroit, 1918: 101; Santschi, 1921a: 110; Menozzi, 1922: 325; Müller, 1923: 43; Finzi, 1926: 98; Karavaiev, 1926: 95; Santschi, 1931: 341; Bernard, 1967: 116; Tarbinsky, 1976: 41; Kutter, 1977: 69; Arnol'di and Dlussky, 1978: 534; Collingwood, 1979: 55; Seifert, 1988: 27; Atanassov and Dlussky, 1992: 95; Choi, 1996a: 8; Choi, 1996b: 46.

Remarks. Kim (1996) recorded this species from Korea, but no specimen was found in this study. This needs further investigation.

Distribution. Korea (?), England and Russia.

5. *Myrmica yoshiokai* Weber 1947

Myrmica rubra yoshiokai Weber, 1947, Ann. Entomol. Soc. Am. 40: 451.

Myrmica yoshiokai: Collingwood, 1981: 26; Kim, 1996: 180.

Remarks. Kim (1996) recorded this species from Korea, but no specimen was found in this study. Kim's citation is probably based on Collingwood (1976)'s record.

Distribution. Korea (?) and Japan.

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References

- André, E. 1883. Species des Hyménoptères d'Europe and d'Algérie 2: 281-344.
- Arnol'di, K.V. 1930. Studien über die Systematik der Ameisen. VI. Eine neue parasitische Ameise, mit Bezugnahme auf die Frage nach der Entstehung der Gattungsmerkmale bei den parasitären Ameisen. Zool. Anz. 91: 267-283.
- Arnol'di, K.V. 1968. Important additions to the myrmecofauna (Hymenoptera, Formicidae) of the USSR, and descriptions of new forms. [In Russian.] Zool. Zh. 47: 1800-1822.
- Arnol'di, K.V. and G.M. Dlussky. 1978. Superfam. Formicoidea. 1. Fam. Formicidae ants. Pp. 519-556. in: Medvedev, G. S. (ed.) Keys to the insects of the European part of the USSR. Vol. 3. Hymenoptera. Part 1. [In Russian.] Opredeliteli Faune SSSR 119: 3-584.
- Atanassov, N. and G.M. Dlussky. 1992. Fauna of Bulgaria. Hymenoptera, Formicidae. [In Bulgarian.] Fauna Bulg. 22: 1-310.
- Bernard, F. 1967. Faune de l'Europe et du bassin Méditerranéen 3. Les fourmis (Hymenoptera Formicidae) d'Europe occidentale et septentrionale. Paris: Masson. 411pp.
- Bondroit, J. 1910. Les fourmis de Belgique. Ann. Soc. Entomol. Belgique 53: 479-500.
- Bondroit, J. 1912. Fourmis des Hautes Fagnes. Ann. Soc. Entomol. Belgique 56: 351-352.
- 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 (Formicidae) 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. Distribution of Ants (Formicidae) in Korea (16). Ant Fauna from Chollabukdo. Korean J. Soil Zoology 1(1): 5-23.
- Choi, B.M. 1996b. Distribution of Ants (Formicidae) in Korea (17). Distribution map of Province. Sci. Edu. Cheongju Natl. Univ. Edu. 17: 41-89.
- Choi, B.M. 1997. A Guide for the Identification of Korea Ants (I). Sci. Edu. Cheongju Natl. Univ. Edu. 18: 51-77.
- Choi, B.M. 1998. Distribution of Ants (Formicidae) in Korea (19). Ant Fauna from Chungcheongbukdo Province. Cheongju Tea. Coll. 35: 213-266.
- Choi, B.M. and J.R. Bang. 1992a. Studies on the Distribution of Ants (Formicidae) 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 (11). Ant Distribution in Kyeongsangbukdo. Sci. Edu. Cheongju Natl. 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., M. Kondoh and M.K. Choi. 1985. Study on Distribution of Ants (Formicidae) from Korea (2). Formic fauna in Mt. Halla. Cheongju Tea. Coll. 22: 439-462.
- 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 Mt. Huksong. Sci. Edu. Cheongju Natl. Univ. Edu. 20: 21-26.
- Cole, A.C. 1957. Paramyrmica, a new North American genus of ants allied to *Myrmica* Latreille. (Hymenoptera: Formicidae). J. Tennessee Acad. Sci. 32: 37-42.
- Collingwood, C.A. 1958. The ants of the genus *Myrmica* in Britain. Proc. R. Entomol. Soc. Lond. (A) 33: 65-75.
- Collingwood, C.A. 1962. Some ants (Hym. Formicidae) from north-east Asia. Entomol. Tidskr. 83: 215-230.
- Collingwood, C.A. 1976. Ants (Hymenoptera, Formicidae)

- from North Korea. Ann. His.-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, 174pp.
- Dlussky, G.M. and B. Pisarski. 1970. Formicidae aus der Mongolei. Ergebnisse der Mongolisch-Deutschen Biologischen Expeditionen seit 1962. Mitt. Zool. Mus. Berlin 46: 85-90.
- Donisthorpe, H. 1915. British ants, their life-history and classification. Plymouth: Brendon & Son Ltd., 379pp.
- Elmes, G.W., A.G. Radchenko and B.J. Kim. 2001. Two New Species of *Myrmica* (Hymenoptera, Formicidae) from Korea. Korean J. Biol. Sci. 5: 107-112.
- Emery, C. 1907. Una formica nuova italiana spetante ad un nuovo genere. Rend. Sess. R. Accad. Sci. Ist. Bologna 11: 49-51.
- Emery, C. 1908. Beiträge zur Monographie der Formiciden des palaearktischen Faunengebietes. Dtsch. Entomol. Z. 1908: 165-205.
- Emery, C. 1916. Fauna Entomologica Italiana. 1. Hymenoptera, Formicidae. Boll. Soc. Entomol. Ital. 47: 79-275.
- Finzi, B. 1926. Le forme europee del genere *Myrmica* Latr. Primo contributo. Boll. Soc. Adriatica Sci. Nat. 29: 71-119.
- Forel, A. 1874. Les fourmis de la Suisse. Systematique. Notices anatomiques et physiologiques. Architecture. Distribution géographique. Nouvelles expériences et observations de mœurs. Neue Denkschr. Allg. Schweiz. Ges. Gesamm. Naturwiss. 26: 1-447.
- Forel, A. 1892. Die Ameisenfauna Bulgariens. (Nebst biologischen Beobachtungen.) Verh. Zool.-Bot. Ges. Wien 42: 305-318.
- Forel, A. 1901. Varieties myrmecologiques. Ann. Soc. Entomol. Belg. 45: 334-382.
- Forel, A. 1907. Formiciden aus dem Naturhistorischen Museum in Hamburg. II. Teil. Neueingänge seit 1900. Mitt. Naturhist. Mus. Hamb. 24: 1-20.
- Forel, A. 1911. Die Ameisen des K. Zoologischen Museums in Muenchen. Sitzungsber. Bayer. Akad. Wiss. Muenchen Math.-Phys. Klasse 1911: 249-303.
- Forel, A. 1915. Fauna insectorum helvetiae. Hymenoptera. Formicidae. Die Ameisen der Schweiz. Mitt. Schweiz. Entomol. Ges. 12: 1-77.
- Holgersen, H. 1942. Ants of northern Norway (Hym., Form.). Tromsø Mus. Årsh. 63 (2): 1-34.
- Karavaiev, V. 1927. The ant fauna of Ukraine. [In Ukrainian.] Tr. Ukr. Akad. Nauk. Fiz.-Mat. Vidd. 4: 247-296.
- Kim, B.J. 1996. Synonymic List and Distribution of Formicidae (Hymenoptera) in Korea. Entomol. Res. Bull. Suppl. (KEI): 169-196.
- Kim, C.H. and B.M. Choi. 1987. On the kinds of Ants (Hymenoptera Formicidae) and vertical Distribution in Mt. Chiri. Korean J. Plant Prot. 26 (3): 123-132.
- Kupyanakaya, A.N. 1986. Ants (Hymenoptera, Formicidae) of the group *Myrmica* lobicornis Nylander from the Far East. [In Russian.] Pp. 83-90. In: Ler, P.A. (ed.) Systematics and ecology of insects from the Far East. [In Russian.] Vladivostok: Akademiya Nauk SSSR, 155pp.
- Kupyanakaya, A.N. 1990. Ants of the Far East USSR. [In Russian.], Vladivostok: Akademiya Nauk SSSR, 258pp.
- Kutter, H. 1977. Hymenoptera, Formicidae. Insecta Helv. Fauna 6: 1-298.
- Latreille, P.A. 1804. Tableau methodique des insectes. Classe huitieme. Insectes, Insecta. Nouveau Dictionnaire d'Histoire Naturelle 24: 129-200.
- 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. 1886. Die Formiciden der Vereinigten Staaten von Nordamerika. Verh. Zool.-Bot. Ges. Wien 36: 419-464.
- Menozzi, C. 1918. Primo contributo alla conoscenza della fauna mirmecologica del Modenese. Atti Soc. Nat. Mat. Modena (5) 4: 81-88.
- Menozzi, C. 1925. Res Mutinenses. Formicidae (Hymenoptera). Atti Soc. Nat. Mat. Modena 55: 22-47.
- Müller, G. 1923. Le formiche della Venezia Giulia e della Dalmazia. Boll. Soc. Adriat. Sci. Nat. Trieste 28: 11-180.
- Nasonov, N.V. 1889. Contribution to the natural history of the ants, primarily of Russia. 1. Contribution to the ant fauna of Russia. [In Russian.] Izv. Imp. Obshch. Lyubit. Estestvozn. Antropol. Andnogr. Imp. Mosk. Univ. 58: 1-78.
- Novák, V. and J. Sadil. 1941. Klíč k urcování mravencu střední Evropy se zvláštním zretelem k mravenci zvláště Cech a Moravy. Entomol. Listy 4: 65-115.
- Nylander, W. 1846. Adnotationes in monographiam formicarum borealium Europae. Acta Soc. Sci. Fenn. 2: 875-944.
- Ogata, K., Y. Hirashima, T. Miura, Y. Maeta, K. Yano and J.H. Ko. 1985. Ants collected in pine forests infested by the pine needle gall midge in Korea (Hymenoptera, Formicidae). Esakia 23: 159-163.
- Onoyama, K. 1989. Confirmation of the occurrence of *Myrmica rubra* (Hymenoptera, Formicidae) in Japan, with taxonomic and ecological notes. Jpn. J. Entomol. 57: 131-135.
- Pisarski, B. 1969. Myrmicidae und Formicidae. Ergebnisse der zoologischen Forschungen von Dr. Kaszab, Z. in der Mongolei (Hymenoptera). Faun. Abh. Staatl. Mus. Tierk. Dresden 2: 295-316.
- 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.
- Santschi, F. 1919. Fourmis d'Espagne et des Canaries. Bol. R. Soc. Esp. Hist. Nat. 19: 241-248.
- Santschi, F. 1931. Notes sur le genre *Myrmica* (Latreille). Rev. Suisse Zool. 38: 335-355.
- Santschi, T. 1937. Fourmis du Japon et de Formose. Bull. Ann. Soc. Entomol. Belg. 77: 361-388.
- Saunders, E. 1880. Synopsis of the British Heterogyna and fossorial Hymenoptera. Trans. Entomol. Soc. Lond. 1880: 201-304.
- Seifert, B. 1988. A taxonomic revision of the *Myrmica* species of Europe, Asia Minor, and Caucasus (Hymenoptera, Formicidae). Abh. Ber. Naturkundermus. Goerlitz 62: 1-75.
- Stärcke, A. 1927. Beginnende Divergenz bei *Myrmica* lobicornis Nyl. Tijdschr. Entomol. 70: 73-84.
- Stitz, H. 1939. Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise. 37. Theil. Hautflüger oder Hymenoptera. I: Ameisen oder Formicidae. Jena: Fisher, G. 428pp.
- Teranishi, C. 1940. Works of Cho Teranishi. Memorial Volume. Osaka: Kansai Entomol. Soc., 312 + (posthumous section) 95pp.
- 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.
- Weber, N.A. 1947. A revision of the North American ants of the genus *Myrmica* Latreille with a synopsis of the Palaearctic species. I. Ann. Entomol. Soc. Am. 40: 437-474.