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A taxonomic revision of the ant genus *Myrmica* LATREILLE, 1804 from the Himalaya (Hymenoptera, Formicidae)

by Alexander G. Radchenko & Graham W. Elmes

Abstract. Thirty species of *Myrmica* LATREILLE, 1804 from the southwestern slopes of the Himalaya and associated mountains are revised and a key to their identification is provided. Fifteen recently described species are included in the revision and 7 previously described forms are considered as synonyms. The species are grouped together in a way believed to loosely reflect their phylogeny. It is concluded that the Himalayan *Myrmica* comprises a unique fauna with virtually no overlap with those of nearby biogeographical regions. Only one species *Myrmica kozlovi* RUZSKY, 1915 appears to have crossed the Himalayan barrier from east to west, while two others appear to have invaded via the mountains of the northwest. It is concluded that the majority of species comprise a relict fauna that is more closely related to the ancestral forms of the genus than to most modern Palaearctic species. This is discussed briefly in terms of the evolution of the genus *Myrmica*.

Key words: Ants – Formicidae – *Myrmica* LATREILLE – taxonomy – new synonyms – Himalaya – Bhutan – Nepal – India – Pakistan – Afghanistan

Introduction

This study deals only with species of *Myrmica* LATREILLE, 1804 which live on the southwestern slopes of the Himalaya and adjacent territories of India, Pakistan and Afghanistan (hereafter called Himalayan *Myrmica*). These form a unique fauna. We have found no overlap between the Himalayan *Myrmica* and the species of Southeast Asia, East Asia and “Middle” Asia (i.e. Turkmenistan, Uzbekistan, Kirgizstan and Tadzhikistan), Mongolia, and Siberia. Furthermore, the species of the northeastern slopes of the Himalaya and adjacent territories of Tibet and western China also are, with the exception of one species, quite distinct from the Himalayan *Myrmica*, being related to the *Myrmica* fauna of East and Middle Asia.

The first described indisputable Himalayan *Myrmica* species was *M. rugosa* MAYR, 1865. From the early 20th century until 1988, a further 20 species and infraspecific forms were added to the Himalayan *Myrmica* fauna (FOREL 1902, 1904a,b, 1906; DONISTHORPE 1929; MENOZZI 1939; WEBER 1947, 1950; BOLTON 1988). Some additional information and notes on these “old” *Myrmica* species can be found in BINGHAM (1903), EMERY (1908), STÄRCKE (1935), EIDMANN (1942), COLLINGWOOD (1961, 1970) and PISARSKI (1967a,b). Previously unknown queens and males from 7 of the “old” species have been described by RADCHENKO & ELMES (*in press*). Recently we added a further 15 new species to the list of Himalayan *Myrmica* (RADCHENKO & ELMES 1998, 1999a). Thus, not only is the last key to the Himalayan *Myrmica* species (MENOZZI 1939) hard to obtain, it is now quite out of date. In this paper we fully revise the Himalayan *Myrmica* species and provide a key for their identification (based on workers). Nine species had a dubious taxonomic status in *Myrmica* (see below) and are excluded from the revision and key.

Subsequent to the description of 15 species by RADCHENKO & ELMES (1998, 1999a) and the synonymies made below, we recognize 30 Himalayan *Myrmica* species. These

are separated into species-groups (some comprising several complexes) following RADCHENKO (1994a). However, many of the Himalayan species could not be placed into any of the 8 species-groups of Palaearctic *Myrmica* that were previously recognized by Radchenko. Although Radchenko's system of groups should eventually be replaced by a full phylogenetic analysis, it remains useful to illustrate how the Himalayan fauna relates to the other Palaearctic species. We propose 12 groups (Fig. 40): 5 new groups (*inezae*, *pachei*, *smythiesii*, *tibetana* and *kurokii*) and 7 of Radchenko's previous groups (the parasitic *arnoldii*-group is best combined with the host *lobicornis*-group). Even then, we can not satisfactorily assign 5 Himalayan species to any group.

Dubious species

The following Indian species listed under *Myrmica* in BOLTON's (1995) catalogue are not included in our list and key to Himalayan *Myrmica* because either they are not *Myrmica* or they have uncertain taxonomic status.

Myrmica kirbii SYKES, 1835 was the first Indian species attributed to the genus *Myrmica*, but this species clearly belongs to the genus *Crematogaster* LUND, 1831. Several of the "*Myrmica*" species described by JERDON (1851), were placed in other genera (BOLTON 1995). Although the remaining one, *M. caeca* JERDON, is almost certainly not a *Myrmica* species because the workers were described as blind with antennal scrobes on the sides of their head (characters never found in *Myrmica*), the original description is insufficient for us to assign *M. caeca* to any other modern genus; so we follow BOLTON (1995) and leave it in *Myrmica* as *incertae sedis*. SMITH (1858) described three species: *M. humilis* (queen), *M. rugifrons* (queen) and *M. bidentata* (workers). BOLTON (1995) considered first two to be *incertae sedis* in *Myrmica* and the last to be a good species. However, probably none of them belong to genus *Myrmica* which has a palp formula of 6,4, because Smith described them all with palp formulae 2,2. *Myrmica humilis* is difficult to place in any modern genus, having a propodeum with two short blunt denticles and being very small (1.25 line [SMITH 1858] which is about the same size as workers of *Monomorium gracillimum* [SMITH 1861]), so we leave it as *incertae sedis* in *Myrmica*. We assign the queen of *M. rugifrons* to the genus *Monomorium* MAYR, 1855 (comb.nov.) because it is more than twice the size of *M. humilis* (3 lines), pale yellow in colour, with the occipital margin of the head is slightly concave and the "metathorax concavely truncate at the apex, a short spine on each side at the verge of the truncation" (SMITH 1858: 124). We also transfer *M. bidentata* to the genus *Monomorium* (comb.nov.) because its workers are very small (1.5 lines), with a long, very smooth and shiny head, small eyes and the propodeum with only short tubercles (although it could less probably belong to genus *Solenopsis* WESTWOOD, 1840).

Later, SMITH (1878) described 3 other *Myrmica* from India: *M. cursor* (queen, no locality), *M. breviceps* (queen, no locality) and *M. luctosa* (male) from the Punjab Hills. The types of these species are not in the Natural History Museum, London, or any other known collections, and can be considered lost. Based on the original descriptions, it is impossible to decide between which of several genera of Myrmicinae these species might belong: therefore we propose formally, that *M. cursor* F. SMITH, *M. breviceps* F.

SMITH and *M. luctosa* F. SMITH are considered *incertae sedis* in the genus *Myrmica*. Finally, based on MUKERJEE'S (1934) description and drawings, we transfer *M. beesonii* MUKERJEE to the genus *Tetramorium* MAYR, 1855 (comb.nov.). Furthermore, its type locality of Madras, in southern India, is well outside the confirmed geographical range of *Myrmica*. Mukerjee stated that the types were in the Natural History Museum, London, but there is no record of them there and they are probably lost.

Material and Methods

Source of material

This revision is based equally on personal examination of the existing types of all described *Myrmica* species and infraspecific forms from the studied region, and on non-type material (about 2000 specimens) from museums and private collections: Naturhistorisches Museum, Basel, Switzerland (NHMB); The Natural History Museum, London, UK (BMNH); The Hope Collections, University Museum, Oxford, UK (UMO); Museum of Comparative Zoology of Harvard University, USA (MCZ); Museum d'Histoire Naturelle, Geneva, Switzerland (MHNG); Museum für Naturkunde der Humboldt-Universität, Berlin, Germany (MNHU); Naturhistoriska Riksmuseet, Stockholm (NHRM); Museo Civico di Storia Naturale di Milano, Italy (MSNM); Institute of Zoology of Ukrainian National Academy of Sciences, Kiev, Ukraine (IZK); Zoological Museums of Moscow State University, Russia (ZMMU); Zoological Institute of Russian Academy of Sciences, St.-Petersburg, Russia (ZIP); Philip Ward, University of California, USA (Ward); Graham Elmes, CEH Dorset, UK (Elmes); Fabrizio Rigato, University of Milan, Italy (Rigato); Maurizio Mei, Istituto di Zoologia, Roma, Italy (Mei); Cedric Collingwood, Leeds, UK (Collingwood); Andreas Schulz, Leilingen, Germany (Schulz); Jochen Martens, University of Mainz, Germany (Martens).

Measurements and indices

The following measurements and indices are used to compare species (for a full description of these see RADCHENKO & ELMES 1998, 1999a): HL (length of head in dorsal view, measured in a straight line from the anterior point of median clypeal margin to mid-point of the occipital margin); HW (maximum width of head in dorsal view behind the eyes); FW (minimum width of frons between the frontal lobes); FLW (maximum width between external borders of the frontal lobes); SL (maximum straight-line length of antennal scape seen in profile); AL (for workers only, being the diagonal length of the alitrunk seen in profile from the neck shield to the posterior margin of the propodeal lobes [note that in previous publications we used the term metapleural lobes]); PL (maximum length of petiole in profile); PH (maximum height of petiole in profile); ESL (maximum length of propodeal spine in profile); ESD (distance between tips of propodeal spine). Indices: Cephalic CI = HL / HW; Frontal-lobe FLI = FLW / FW; Scape1 SI1 = SL / HL; Scape2 SI2 = SL / HW; Petiole1 PI1 = PL / PH; Petiole2 PI2 = PL / HW; Spine-length ESLI = ESL / HW; Spine-width ESDI = ESD / ESL.

Taxonomy

The Himalayan *Myrmica* species (with synonymies) recognised here.

***ritae*-group**

indica WEBER

= *ritae* (misidentification – COLLINGWOOD 1970) not *ritae* EMERY

urbanii RADCHENKO & ELMES

boltoni RADCHENKO & ELMES

martensi RADCHENKO & ELMES

collingwoodi RADCHENKO & ELMES

***rugosa*-group**

rugosa MAYR

rupestris FOREL

= *debilior* FOREL

= *everesti* DONISTHORPE

= *rugosomythiesi* FOREL

foreliana RADCHENKO & ELMES

= *carbonaria* FOREL (jun. primary homonym)

aimonissabaudiae MENOZZI

= *dicaporiacoi* MENOZZI

hecate WEBER

ereptrix BOLTON

cachmiriensis FOREL

= *lutescens* MENOZZI

wardi RADCHENKO & ELMES

ordinaria RADCHENKO & ELMES

***smythiesii*-group**

smythiesii FOREL

= *himalayana* WEBER

fortior FOREL

wittmeri RADCHENKO & ELMES

***inezae*-group**

inezae FOREL

rigatoi RADCHENKO & ELMES

***pachei*-group**

pachei FOREL

villosa RADCHENKO & ELMES

***tibetana*-group**

tibetana MAYR

tenuispina FOREL

***kurokii*-group**

kozlovi RUZSKY

= *specularis* DONISTHORPE

Species with unresolved taxonomic position*brancuccii* RADCHENKO & ELMES*vittata* RADCHENKO & ELMES*williamsi* RADCHENKO & ELMES*nitida* RADCHENKO & ELMES*rhytida* RADCHENKO & ELMES*petita* RADCHENKO & ELMES***ritae*-group**

This group was revised by RADCHENKO & ELMES (1998) who recognized 11 species (one has since been moved to the *inezae*-group – see below). These species have a morphology that clearly separates them from any other *Myrmica* worldwide. They are believed to be morphologically “primitive” because fossil *Myrmica* resemble this group more than any of the others. The workers are characterized by large size (HW up to 1.62, AL up to 2.60 mm), very long propodeal spines (ESLI 0.44–0.73), long and low petiole (PI1 1.38–2.19, PI2 0.43–0.68), long antennal scapes (often longer than the head) and by propodeal lobes that are sharply pointed at the apex. The antennal scape of the males is short (SI1 0.35–0.49). The *ritae*-group is easily separated into two complexes (RADCHENKO & ELMES 1998): 2 members of the *ritae*-complex (total 7 species) and all the *boltoni*-complex (3 species) are found in the Himalaya. The *ritae*-complex is characterized by a very coarsely rugose head and alitrunk, and by smooth surfaces between rugae on the head dorsum, whereas the *boltoni*-complex has much more finely rugulose or even striated head and alitrunk, and head dorsum with distinctly punctured surfaces between the rugae.

ritae*-complex**Myrmica indica* WEBER**

Figs 1–2

Myrmica ritae subsp. *indica* WEBER, 1950, Ann. ent. Soc. Am. 43: 221. **Lectotype**, worker and 1 **paralectotype**, worker (MCZ): India, Darjeeling distr., E Himalayas, Tonglu, 10000', 22.iv.[19]10, Beebe (examined, designated by RADCHENKO & ELMES, 1998).

Myrmica indica: RADCHENKO, 1994, Zool. Zh. 73: 44 (raised to species).

Myrmica indica: BOLTON, 1995, New general catalogue ants: 279.

Myrmica indica: RADCHENKO & ELMES, 1998, Vest. Zool. 32: 11 (description of queen and male).

Myrmica ritae: COLLINGWOOD, 1970, Khumbu Himal. 3: 374 (Nepal – misidentification).

Other material examined (NHMB, BMNH, IZK, Martens, Schulz, Elmes): **India**: 1 worker, Darjeeling, Tiger Hill, 2000 m, 27.v.1975, Wittmer; 1 worker, India (without locality); **Nepal**: 3 workers, Chordung, Jiri, 2900 m, 1.iv.1973, Martens; 15 workers, Thodung, 2–9.iv.1973, Martens; 1 worker, Shiralaybis, Jiri–grat, 2200 m, 8.iv.1973, Martens; 9 workers, Jiri–Thodung, 28.v.1976, Wittmer & Baroni Urbani; 12 workers, 1 queen, Phulchoki, 2600 m, 11–14.vi.1976, Wittmer & Baroni Urbani; 1 worker, Zentral–Nepal, Zw.Tare–Pati, u. Gasaikunde, ix–x.197, Franz; 2 workers, Taplejung, Simbua Khola, vicinity Lassetham, 3000–3150 m, 15.v.1988, Martens & Schawaller; 2 workers, 2 males, Sankhua, Sabha, vic. Phakhola, 31.v–3.vi.1988, 2600–2800 m, Martens & Schawaller; 1 worker, Maeva Khola, Sanghu, 29.vi.1961, oak forest, in litter, Hyatt; 1 worker, Chautra, Nanling Lekh, 9500', 19.vi.1933, Brendell; 1 worker, Phulkhola, 9000', 30.v.1933,

Brendell; **Bhutan**: 10 workers, Thimphu, 31.v.1972, (NHMB Bhutan Expedition, 1972); 10 workers, Sampa-Kotoka, 1400–2600 m, 9.vi.1972, (NHMB Bhutan Expedition, 1972); 3 workers, Nobding, 41 km O Wangdi, 2800 m, (NHMB Bhutan Expedition, 1972).

Distribution. Himalaya, Bhutan, Sikkim, Nepal.

Notes. *Myrmica indica* was originally described as a subspecies of *M. ritae* and was raised to species status by RADCHENKO (1994a); queen and male were described by RADCHENKO & ELMES (1998). *M. indica* most resembles *M. serica* WHEELER, however workers and queens clearly differ from *M. serica* by having sparser outstanding hairs on the occipital margin of the head, the absence of hairs on the genae and by the darker colour of the body. Material from Nepal that was determined as *M. ritae* by COLLINGWOOD (1970) is *M. indica* (examined). Nothing is known of its ecology other than it is found at altitudes between 2000 and 3150 m.

Myrmica urbanii RADCHENKO & ELMES

Fig. 3

Myrmica urbanii RADCHENKO & ELMES, 1998, Vest. Zool. 32: 16. **Holotype**, worker (BMNH): India: Shillong, Mawphlang, East Khasi, 3200', 2.v.[19]86, Darlong. **Paratypes** (BMNH, NHMB, IZK, Elmes): 86 workers from the same nest as holotype; 2 workers, India, Mawphlang, Megalaya, 1850 m, 15.v.1976, Wittmer & Baroni Urbani; 6 workers, India, Upper Shillong, Megalaya, 1900 m, 13.v.1976, Wittmer & Baroni Urbani.

Distribution. NE India (Shillong).

Notes. Queens and males are unknown. *Myrmica urbanii* clearly differs from *M. indica* by having much more abundant outstanding hairs on the sides of the head, and by a coarse reticulate sculpture on the rear third of the head dorsum. Ecology is poorly known. It has been found at altitudes of 1000–1900 m and one nest was found in soil beneath a log in *Quercus* forest.

boltoni-complex

Myrmica boltoni RADCHENKO & ELMES

Figs 6–7

Myrmica boltoni RADCHENKO & ELMES, 1998, Vest. Zool. 32: 18. **Holotype**, worker (BMNH): Nepal, Dhorpantan, 3000 m, 20.v.1973, Martens. **Paratypes** (BMNH, NHMB, IZK, Elmes, Ward, Martens, Schulz): 15 workers with same label (probably same nest) as holotype; 3 workers, Nepal, Umg. Goropani, w. Pokhara, Sept.–Oct. 1971, Franz; 1 worker, Nepal, 2 miles SE Sikha, 7800–8000', 21–22.v.1954, Quinlan; 1 worker, Nepal, 18 km NNE Baglung, 28°24' N, 83°42' E, 2540 m, 29.xi.1988, No. 9619, Ward; 1 worker, Nepal, Kosi, Distr. Sankhuwasawa, Vallee d'Induwa Koa, 2000 m, 16.iv.1984, Löbl & Smetana; 1 worker, Nepal, Manang, Marsyandi, 2550 m, 14–17.iv.1980, Martens & Ausobsky; 2 workers, Nepal, Mustang, Lethe, 2450–2600 m, 30.iv.1980, Martens & Ausobsky; 1 worker, Nepal, Gokha, Chuving Khola, Meme Kharka, 3300–3400 m, Martens & Schawaller.

Distribution. Nepal.

Notes. Queens and males are unknown. *Myrmica boltoni* differs from all members of the *ritae*-complex by the much finer rugosity on its body, and by the dull, dense and coarsely punctured surface of the head. Its ecology is unknown, but one worker was collected under rotten wood in a *Quercus-Rhododendron* forest (P. S. Ward, *pers. comm.*).

***Myrmica martensi* RADCHENKO & ELMES**

Fig. 8

Myrmica martensi RADCHENKO & ELMES, 1998, Vest. Zool. 32: 21. **Holotype**, worker (NHMB): Nepal, Gosainkund, Sing Gyang, 3200 m, 26.iv.1973, Martens; **Paratypes** (NHMB, BMNH, IZK): 3 workers and 1 queen with same label (probably same nest) as holotype.

Distribution. Nepal.

Notes. Males are unknown. *Myrmica martensi* is closely related to *M. boltoni* from which workers differ by shorter, upward-pointing and distinctly divergent propodeal spines, by a distinctly shorter petiole and by its more feebly developed sculpture on alitrunk and pedicel. The queen differs from other known queens of the *ritae*-group by having much less coarse sculpture of the body, and distinctly punctured surfaces between rugae on the dorsum of the head and alitrunk. Its ecology is unknown.

***Myrmica collingwoodi* RADCHENKO & ELMES**

Figs 4–5

Myrmica collingwoodi RADCHENKO & ELMES, 1998, Vest. Zool. 32: 23. **Holotype**, worker (NHMB): Bhutan, Dorjula, 3100 m, 26.vi.1972, (NHMB Bhutan Expedition, 1972), Alk. No 56. **Paratypes** (NHMB, BMNH, IZK, Elmes): 9 workers and 1 queen with same label (probably same nest) as holotype; 6 workers with same label but date of collecting 6.vi.1972, (NHMB Bhutan Expedition, 1972); 6 workers, Dorjula, 2450–3100 m, 6.vi.1972, (NHMB Bhutan Expedition, 1972) .

Distribution. Bhutan.

Notes. Males are unknown. *Myrmica collingwoodi* is closely related to the other species of the *boltoni*-complex, differing by a much more finely punctured head dorsum, the generally finer sculpture of the alitrunk dorsum, possession of outstanding hairs on the temples and genae, and by a lighter colour. It differs specifically from *M. martensi* by a distinctly longer petiole and propodeal spines, and from *M. boltoni* by straight propodeal spines, which are directed backwards and upwards.

***rugosa*-group**

Species in this group have workers with antennal scapes that are slightly curved at their bases, not angulate and without trace of a lobe. In this respect they are superficially similar to the *rubra*-group (RADCHENKO 1994a), but the males are quite distinct, having short antennal scapes ($SI1 < 0.56$, $SI2 < 0.65$). We recognise two complexes within this group. Species in the *rugosa*-complex are characterized by a coarser sculpture of the body, the promesonotal dorsum (in profile) forming a more or less regular arch and a mesonotum that is not impressed transversely, but gently curves down to the propodeum to form a metanotal groove that is generally shallow (although sometimes it can be quite deep). Species of the *cachmiriensis*-complex have the contrary characteristics: a finer sculpture, a transversely impressed mesonotal dorsum (sometimes saddle-shaped) that curves down abruptly to the propodeum to form deep and wide metanotal groove (compare Figs 32, 34, 39).

rugosa-complex*Myrmica rugosa* MAYR

Figs 31–32

Myrmica rugosa MAYR, 1865, Zool. Theil 2: 19. **Lectotype**, worker (MNHU): “Himalaya”. (examined, designated here). **Paralectotype**, worker (BMNH): Himalaya. (examined, designated here), **not** WEBER, 1947, Ann. ent. Soc. Am. 40: 462.

Myrmica rugosa: BINGHAM, 1903, Fauna of British India 2: 268 (key and distribution).

Myrmica rugosa: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 658 (distribution).

Myrmica rugosa: FOREL, 1906, Bull. Soc. vaud. Sci. nat. 42: 87 (distribution).

Myrmica rugosa: EMERY, 1908, Dt. ent. Z. 1908: 168 (key).

Myrmica rugosa: EMERY, 1921, Genera Insectorum 174A: 40 (catalogue).

Myrmica rugosa: DONISTHORPE, 1929, Ann. Mag. Nat. hist. 4: 445 (distribution).

Myrmica rugosa: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 129 (catalogue).

Myrmica rugosa: BOLTON, 1995, New general catalogue ants: 282.

Myrmica rugosa: RADCHENKO & ELMES, Vest. Zool 34: (in press.) (description of queen and male).

Other material examined (NHMB, BMNH, IZK, Elmes, Ward): **India**: 5 workers, Kashmir, Srinagar, 34° 04' N, 74° 50' E, 1560 m, 25.viii.1978, No. 3113, in garden, Ward; 2 workers, Kashmir, Lidderwat, 34° 09' N, 75° 15' E, 2150 m, v.1978, Weare. **Nepal**: 7 workers, Thakkhola, Alt-Marsa, 3100–3200 m, 6–7.vii.1973, Martens. **Bhutan**: 7 workers, 2 queens, 20 km S Thimphu, 2440 m, 16.iv.1972, (NHMB Bhutan Expedition, 1972); 13 workers, same locality, 16–27.iv.1972, (NHMB Bhutan Expedition, 1972); 29 workers, 3 queens, 1 male, same locality, 31.v.1972, (NHMB Bhutan Expedition, 1972); 20 workers, same locality, 2300 m, 2–8.v.1972, (NHMB Bhutan Expedition, 1972); 33 workers, Sampa-Kotoka, 1400–2600 m, 9.vi.1972, (NHMB Bhutan Expedition, 1972); 5 workers, Doriula, 2900 m, 26.vi.1972, (NHMB Bhutan Expedition, 1972); 11 workers, Kotoka-Gogona, 2600–3400 m, 10.vi.1972, (NHMB Bhutan Expedition, 1972); 6 workers, 2 males, Diechli Paka, 3300 m, 19–20.vi.1972, (NHMB Bhutan Expedition, 1972); 24 workers, 2 queens, 13 males, Tanglu, 22 km W Thimphu, 2600–2800 m, 30.vi.1972, (NHMB Bhutan Expedition, 1972); 13 workers, Para, 2300 m, 29.v.1972, (NHMB Bhutan Expedition, 1972); 13 workers, Passeling, 2700–3100 m, 23.v.1976, Roder & Caminada.

Distribution. Himalaya (India, Nepal and Bhutan).

Notes. We were confused about the identification of *M. rugosa*, based on WEBER's (1947) redescription. In the original description of *M. rugosa* it is stated that this species has reticulated sculpture only on the occiput and lateral parts of the head dorsum, and petiole only densely punctured (MAYR 1865: 19). However, when WEBER (1947: 462) redescribed *M. rugosa* he reported “Surface of head coarsely sculptured: ... clypeus and median dorsal area (frons in our terminology) coarsely rugose, sides rugoso-reticulate... Dorsal surface of petiole deeply vermiculate, sides vermiculate-punctate. Post-petiole coarsely vermiculate-punctate”. These characters contradict Mayr's description but agree well with the characters of *M. rugosa* var. *debilior* FOREL. Mayr gave no date or collector in his original description and only indicated the type locality as “Himalaya”. We found 1 specimen (worker) from MNHU with the labels “Himalaya” and “*M. rugosa* MAYR”, written in Mayr's hand. As this specimen fully agrees with MAYR's description, we have designated it as the lectotype of *M. rugosa*. A similar specimen from BMNH which also had the labels “Himalaya” and “*M. rugosa* sp. n. MAYR” written in Mayr's hand becomes a paralectotype. We compared these with 3 worker “Cotypes” from MCZ with labels “*Myrmica rugosa* MAYR”, “Himalaya (Smythies), Forel coll.”, “M.C.Z. Cotype No. 556”, on which WEBER based his redescription, and concluded that these cotypes are not *M. rugosa*. They really belong to the type series of *M. rugosa* var. *debilior* (see notes to *M. rupestris* FOREL below).

Individuals of *M. rugosa* vary in colour from some with black bodies and dark brown legs, to others with brownish-red bodies and yellowish-red legs (in Mayr's original description colour is given as "*fusconigra, tarsi brunneis*"). The darker specimens differ from the other species in the *rugosa*-complex by presence of coarse reticulation only on the posterior and postero-lateral parts of the head dorsum, and specifically from *M. rupestris* and *M. foreliana* by having only densely punctured, not rugose, petiolar and postpetiolar nodes (see Key and Figs 31–35). Although the lighter specimens are more similar to *M. fortior*, they differ by having frontal carinae which do not curve outwards to merge with the rugae surrounding the antennal sockets. Furthermore, males of *M. rugosa* have much shorter antennal scapes than those of *M. fortior* (SI1 2.0–2.46, SI2 1.76–2.08 versus SI1 1.11–1.16, SI2 1.23–1.36).

The ecology of *M. rugosa* is very poorly known. It has been found at altitudes between 1200 and 3400 m in semi-natural habitats but it also inhabits cultivated areas (P. Ward, pers. comm.). Males and alate queens were caught from the end of May to the end of June, which is extremely early in the year compared to Euro-Siberian *Myrmica* species.

Myrmica rupestris FOREL

Fig. 35

Myrmica smythiesii var. *rupestris* FOREL, 1902, Revue suisse Zool. 10: 227. **Lectotype**, worker and 2 **paralectotypes**, workers on the same pin (NHMG): India, "N-W Himalaya, Ekra Peak, 4400' (Smythies)", "LXXXIX/12, *M. Smythiesii* For. v. *rupestris* For., Typus" (examined, designated here).

Myrmica smythiesi var. *rupestris*: BINGHAM, 1903, Fauna of British India: 269 (key and distribution).

Myrmica smythiesi var. *rupestris*: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 661 (distribution).

Myrmica smythiesi var. *rupestris*: FOREL, 1906, Bull. Soc. vaud. Sci. nat. 42: 87 (distribution).

Myrmica smythiesi var. *rupestris*: EMERY, 1921, Genera Insectorum 174A: 41 (catalogue).

Myrmica smythiesi var. *rupestris*: STÄRCKE, 1935, Wiss. Ergebn. Nederland. Exped. Karakorum: 260 (distribution).

Myrmica smythiesi var. *rupestris*: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 296 (key).

Myrmica smythiesi var. *rupestris* WEBER, 1947, Ann. ent. Soc. Am. 40: 461 (translation of original description to English).

Myrmica smythiesi var. *rupestris*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (misprinting).

Myrmica rupestris: COLLINGWOOD, 1970, Vidensk. Meddr. dansk. naturh. Foren. 123: 374 (raised to species and distribution).

Myrmica smythiesii subsp. *rupestris*: BOLTON, 1995, New general catalogue ants: 282.

Myrmica rupestris: RADCHENKO & ELMES, Vest. Zool. (in press) (description queen and male).

Myrmica rugosa var. *debiliior* FOREL, 1902, Revue suisse zool. 10: 228. **Lectotype**, worker (NHMG): "Himalaya (Smythies)", "LIX/4, *M. rugosa* r. *debiliior*" (examined, designated here). **Paralectotypes**: 2 workers (NHMG) on the same pin as lectotype; 1 worker (UMO) with same labels as lectotype; 3 workers (MCZ), "Himalaya (Smythies)", "FOREL coll.", "M.C.Z. Cotype No. 556" (originally labelled as *M. rugosa* MAYR, see note below) (all examined, designated here) **syn.nov.**, **not** WEBER, 1947, Ann. ent. Soc. Am. 40: 463.

Myrmica rugosa var. *debiliior*: FOREL, 1904, Revue suisse zool. 12: 22 (distribution).

Myrmica rugosa var. *debiliior*: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 661 (distribution).

Myrmica rugosa var. *debiliior*: EMERY, 1921, Genera Insectorum 174A: 40 (catalogue).

Myrmica rugosa var. *debiliior*: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 295 (key).

Myrmica rugosa var. *debiliior*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 129 (catalogue).

Myrmica rugosa subsp. *debiliior*: BOLTON, 1995, New general catalogue ants: 278.

Myrmica rugosa var. *rugososmythiesi* FOREL, 1902, Revue suisse zool. 10: 228, synonymy by FOREL, 1902, Revue suisse zool. 10 : 228 (as synonym of var. *debiliior*) (not examined), **syn.nov.**

Myrmica everesti DONISTHORPE, 1929, Ann. Mag. Nat. hist. 4: 455. **Holotype**, worker (BMNH): Himalaya, Jelap La, Tibetan side, 12000', 1.iv.1924, Hingston (examined). **Paratypes**: 2 workers (BMNH) and one worker (ZMMU) with same labels as holotype (examined) **syn.nov.**

Myrmica everesti: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 295 (key).

Myrmica everesti: WEBER, 1950, Ann. ent. Soc. Am 43: 223 (distribution).

Myrmica everesti: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 125 (catalogue).

Myrmica everesti: COLLINGWOOD, 1970, Khumbu Himal. 3: 374 (distribution).

Myrmica everesti: BOLTON, 1995, New general catalogue ants: 279.

Other material examined (NHMB, BMNH, IZK, Elmes, Schulz, Martens, Collingwood, Ward): **India**: 1 queen, Kashmir, Pahalgam, 39°02' N, 75° 19' E, 27.vii.1978, No. 3009, Ward; 4 workers, Kashmir, Lidderwatt, 34°09' N, 75° 15' E, 2700 m, 30.vii.1978, No. 3030A, Ward; 1 worker, Kashmir, Lidderwat, 2700 m, v.1978, Weare; 2 workers, Himchal Pradesh, vic. Kufri, 15 km E Shimla, 2500–2700 m, 29.ix.1996, Schulz & Vock; 2 workers, C. Himalaya, Tehri Gahmal, Rudugia Gael, 13400', 1952, Lamprey. **Nepal**: 1 worker, Luhme, Wittmer; 5 workers, Padmara-Khari Longa Bumra, 2750–3400 m, 28.v.1977, Wittmer; 12 workers, 2 males, Thodung via Those, 3100 m, 29–31.v.1976, Wittmer & Baroni Urbani; 10 workers, 1 male, Phulchoki, 2600 m, 11–14.vi.1976, Wittmer & Baroni Urbani; 1 queen (dealate), Daman, 2400 m, 4.6.1976, Wittmer & Baroni Urbani; 1 worker, Namsche Bazar, 3450 m, 1976, Bulsev; 1 worker, 18 km NNE Baglung, 28°24' N, 83°42' E, 2540 m, 29.xi.1988, No. 9618, Ward; 57 workers, 16 km SW Jomosom, 28°41' N, 83° 37' E, 2550 m, 3.xii.1988, No. 9633, 9636, Ward; 11 workers, 20 km SSW Jomosom, 28°37' N, 83° 38' E, 2300 m, 4.xii.1988, No. 9642, Ward; 9 workers, W Nepal, Sigarhi-Doti, Lokondo, 7000', 17.vii.1953, Tyson; 1 worker, Siklis, 28,22 N, 84° 06' E, 7000', from sandy turf on mod. acid soil; 6 workers, Gurjakhani, 28°37' N, 83,14 E, 8500', moss on rock, 4–7.vii.1954, Hyatt; 3 workers, Tadopani, 3 km N Pakhar, 2700 m, forest, 10–20.xi.1995, Hocklander; 3 workers, 1 queen, Prov. Taplejung, Omje Kharka, NW Yamputh, 2300–2500 m, 1.vi.1988, Martens & Schawaller; 10 workers, Namde-Jorsla, 2890 m, 11.vi.1979, Tabata. **Bhutan**: 1 worker, Sampa-Kotoka, 2500 m, (NHMB – Bhutan Expedition, 1972); 3 workers, 2 queens, 20 km S Thimphu, 2400 m, 16.iv.1972, (NHMB – Bhutan Expedition, 1972); 13 workers, 2 queens (dealate), Kotoka-Gogona, 2600–3400 m, 10.vi.1972, (NHMB – Bhutan Expedition, 1972); 7 workers, Gogona, 3100 m, 10–12.vi.1972, (NHMB – Bhutan Expedition, 1972); 12 workers, 1 queen, 4 males, Dechli Paka, 3300 m, 19.vi.1972, (NHMB – Bhutan Expedition, 1972); 17 workers, 3 queens, 9 males, same locality, 20.vi.1972, (NHMB – Bhutan Expedition, 1972); 7 workers, Bumthang, vii.1976, Smidhafler; 11 workers, Thang-Rudungla, 2400–3500 m, 5.vi.1976, Caminada; 4 workers, Paesseling, 3100–3400 m, 23.v.1976, Roder & Caminada; 2 workers, Batbalitang (Bumtang), 2600 m, 23–30.v.1976, Roder & Caminada.

Distribution. Himalaya (India, Nepal and Bhutan).

Notes. We have synonymised *M. rugosa* var. *debiliior* and *M. everesti* with *M. rupestris* (according to Recommendation 24A of the International Code of Zoological Nomenclature [ANONYME 1988]). Labels on the type specimens (lectotype and paralectotypes) of *M. smythiesii* var. *rupestris* from NHMG more or less agree with data in FOREL's paper (1902: 227), with only two exceptions: on the label altitude and site are "4400'" and "N-W Himalaya", but in the paper they are given as "9500'" and "N-O Himalaya". We guess that the correct altitude is 9500' because 4400' seems too low for this species. We also studied the holotype and paratypes of *M. everesti*.

The situation regarding the types of *M. rugosa* var. *debiliior* is much more complicated. FOREL (1902) originally gave its type localities as: Himalaya (Smythies); Darjeeling, 3000–8000' (Wroughton); Inde septentrionale (Wroughton); Deota (Smythies); Mysore (Rothney); Kamaon (Schlagintweit). We found 3 workers from NHMG on the same pin, labelled in Forel's own hand as "*M. rugosa* r. *debiliior*, Himalaya (Smythies), LXI/4". We designated the upper specimen as lectotype; the other two specimens plus 1 worker with the same label found in UMO become paralectotypes. All four of these specimens had the characteristics which separates var. *debiliior* and *M. rupestris* from *M. rugosa* – the much coarser sculpture on their petiolar and postpetiolar

nodes, which have both punctures and coarse short sinuous rugae, and their coarsely reticulated head dorsum with only the frons being longitudinally rugulose. We also studied the “type” material of *M. rugosa* var. *debiliior* and *M. rugosa* from MCZ. These have labels (not written in Forel’s hand) saying “Sind Valley, Cachmire, 7000’, Wroughton“, “*M. rugosa* var. *debiliior* FOREL, M.C.Z. Cotype No. 568“. These specimens can not belong to FOREL’s original type series of var. *debiliior* because their locality does not correspond with the original paper (FOREL 1902: 228) and they have no sinuous rugosity on the petiolar and postpetiolar nodes, which are only densely punctured. We identified them as *M. aimonissabaudiae* MENOZZI and because WEBER (1947) redescribed var. *debiliior* based on the series of “cotypes“ from MCZ, his description must be referred to *M. aimonissabaudiae*. We also examined the MCZ “types“ of *M. rugosa* (3 workers) which are not *M. rugosa* but are undoubtedly the same species which we recognised as var. *debiliior*. Furthermore, they are labelled “Himalaya (Smythies), FOREL Coll.“, “M.C.Z. Cotype No. 556“ which agrees with those of our designated lectotype and paralectotypes of var. *debiliior* from NHMG. Therefore we include this “type” series of “*M. rugosa*“ from MCZ as paralectotypes of *M. rugosa* var. *debiliior* (see also notes to *M. rugosa*). Although the types of all three forms synonymised here differ somewhat from each other (mainly by length and shape of the propodeal spines, length of the hairs on the appendages and proportions of HL/HW), all these features fully overlapped when additional material was studied. When more is known of the biology and ecology of the three forms, they might be shown to be separate species, but for now, they are best considered as one.

A little is known about the ecology of *M. rupestris*, it has been collected at relatively higher altitudes than *M. rugosa*, between 2100 and 4100 m. Nests have been found in the soil and often under stones, in open deciduous and mixed forests, and places with steppe-like vegetation (P. WARD *pers. comm.*). Like *M. rugosa*, queens and males have been found in nests of *M. rupestris* from the end of May to the end of June, much earlier than in Euro-Siberian species.

***Myrmica foreliana* RADCHENKO & ELMES nom.nov.**

Myrmica smythiesii r. *carbonaria* FOREL, 1902, Revue suisse zool. 10: 227. Junior primary homonym of *Myrmica carbonaria* F. SMITH, 1858, Cat. Hym. Ins. Coll. British Mus. 6: 127 (transferred to *Monomorium* by Roger, 1863, Berlin. Ent. Z. 7: 31). **Holotype**, worker (NHMG): “Himalaya, Pachmarhi, Shurr, 30.vii.[18]93, Rothney”, (examined).

Myrmica smythiesi r. *carbonaria*: BINGHAM, 1903, Fauna of British India 2: 269 (key and distribution).

Myrmica smythiesi r. *carbonaria*: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 661 (distribution).

Myrmica smythiesi subsp. *carbonaria*: EMERY, 1921, Genera Insectorum 174A: 41 (catalogue).

Myrmica smythiesi subsp. *carbonaria*: WEBER, 1947, Ann. ent. Soc. Am. 40: 458 (translation of original description to English).

Myrmica smythiesi subsp. *carbonaria*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (catalogue).

Myrmica smythiesii subsp. *carbonaria*: BOLTON, 1995, New general catalogue ants: 278.

Notes. This species was described only from the holotype worker. We found no more examples in any of the collections examined. The specimen clearly differs from *M.*

rupestris by a smaller size (HW=0.77, AL=1.46 mm, versus HW > 0.78, AL > 1.80 mm), a somewhat longer head (CI=1.39 versus CI < 1.35) and by the surfaces between rugae of the head and alitrunk being densely punctured and appearing more or less dull. However, additional material is required before a clearer treatment of this species can be made. Queens, males and the ecology of *M. foreliana* are unknown.

Myrmica aimonissabaudiae MENOZZI

Figs 33–34

Myrmica aimonis-sabaudiae MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 286 (also described as a new in WEBER, 1947, Ann. ent. Soc. Am. 40: 464). **Lectotype**, worker (MSNM): [Pakistan] Karakorum, Gund, Valle Sind, 2080 m, 9.iv.1929 (examined, designated here). **Paralectotypes**: 3 workers (MSNM) with same labels as lectotype; 1 queen without gaster and waist (MSNM), Askore, Braldo, 3100 m, 10.viii.1929 (examined, designated here).

Myrmica aimonis-sabaudiae: EIDMANN, 1942, Zool. Jb. 75: 245 (distribution).

Myrmica aimonis-sabaudiae: COLLINGWOOD, 1961, Vidensk. Meddr. dansk. naturh. Foren. 123: 56 (description of male).

Myrmica aimonis-sabaudiae: PISARSKI, 1967, Annls. zool., Warsz. 24: 378 (distribution).

Myrmica aimonis-sabaudiae: PISARSKI, 1967, Polskie Pismo ent. 37: 47 (distribution).

Myrmica aimonissabaudiae: BOLTON, 1995, New general catalogue ants: 277.

Myrmica dicaporiacoi MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 289, (also described as a new in WEBER, 1947, Ann. ent. Soc. Am. 40: 464; see note below). **Lectotype**, worker (MSNM): "Sped. Karakorum, Shigar, 23.8.29, 2200 m" (examined, designated here), **syn.nov.**

Myrmica dicaporiacoi: BOLTON, 1995; New general catalogue ants: 278.

Other material examined (NHMB, BMNH, UMO, IZK, Schulz, Elmes, Rigato, Collingwood, Ward): **India**: 7 workers, Kashmir, Gumlarg, 2650–3000 m, 1–3.vii.1976, Wittmer; 13 workers, Kashmir, Gulmarg-Tangmarg, 2300–2650 m, 3.vii.1976, Wittmer; 7 workers, Kashmir, Ladakh, Khalse, 2900 m, 20.vii.1976, Wittmer; 7 workers, Kashmir, Pahalgam, 2200–3100 m, 7–8.vii.1976, Wittmer & Baroni Urbani; 11 workers, Kashmir, Daksum, 2400–2700 m, 9–17.vii.1976, Wittmer & Baroni Urbani; 1 worker, Kashmir, Phalagam, 30° 02' N, 25° 19' E, v. 1978, Weave; 2 workers, Kashmir, Pahalgam, 10–17.viii.1992, Dakatra; 15 workers, Kashmir, Gumlarg, 20–30.vii.1986, Williams; 11 workers, Kashmir, Pantitop, 29.vii.1986, Williams; 6 workers, Kashmir, Seven Springs, 29.vii.1986, Williams; 2 workers, Kashmir, Pahalgam, 34° 02' N, 75° 19' E, 2190 m, 27.vii.1978, No. 3001, Ward; 15 workers, 10 queens (alate), 3 males, Kashmir, Liddarwat, 34° 09' N, 75° 15' E, 2700 m, 30.vii.1978, No. 3017, 3018A, 3022, 3030B, Ward; 15 workers, 1 queen (dealate), Kashmir, Kulan-Shrinagar, 34° 16' N, 75° 09' E, 2100 m, 8.viii.1978, No. 3050–8,9,11, Ward; 18 workers, 1 queen (dealate), Kashmir, Ladakh, Chellong River, 34° 06' N, 75° 53' E, 3360 m, 17.viii.1978, No. 3073, 3074, Ward; 17 workers, 1 queen (dealate), Kashmir, Ladakh, Panikhar, Suru riv., 34° 07' N, 75° 57' E, 3150 m, 18.viii.1978, No. 3075, No. 3075, 3080, 3081, 3083, Ward; 5 workers, Kashmir, Ladakh, Leh, 34° 11' N, 77° 35' E, 3450 m, 21.viii.1978, No. 3087, 3092, Ward; 5 workers, Kashmir, Ladakh, Khalsi, 34° 19' N, 76° 53' E, 2950 m, 22.viii.1978, No. 3099, Ward; 11 workers, Kashmir, Sonamarg, 34° 18' N, 75° 18' E, 2700 m, 23.viii.1978, No. 3101, Ward; 7 workers, 1 queen (dealate), Kashmir, Dahigam Game Sanctuary, 34° 08' N, 74° 56' E, 1650 m, 24.viii.1978, No. 3106–2, Ward; 13 workers, Himchal Pradesh, Mohri, 3000–3200 m, 15.v.1972, Wittmer & Brancucci; 11 workers, Himchal Pradesh, Manali, 1984, Wittmer & Brancucci; 7 workers, Himchal Pradesh, Manali, 11.x.1979, Boucek; 2 workers, Himchal Pradesh, 3 km E Fagu, 20 km E Shimla, 2300 m, 29.ix.1996, No. 388, Schulz & Vock; 3 workers, Himchal Pradesh, vic. Theong, 25 km E Shimla, 2400 m, 29.ix.1996, No. 395, Schulz & Vock; 3 workers, Himchal Pradesh, Kullu valley, Manali, 2000 m, 1.x.1996, No. 435, Schulz & Vock; 5 workers, 1 queen, Himchal Pradesh, Kullu valley, 5–7 km SW Rottang La Pass, 2500–2900 m, 1.x.1996, No. 430, 431 (workers), 432 (queen), Schulz & Vock; 2 workers, Himchal Pradesh, Kullu valley, vic. Nagga, 20 km SW Manali, 1500–1600 m, 2.x.1996, No. 457, Schulz & Vock; 5 workers, Darjeeling, Bharapabec Lebong, 1800–1900 m, 11.v.1975, Wittmer & Baroni Urbani; 5 workers, Darjeeling, 2000 m; 1 worker, Sikkim, Taungloo, 10000', v.[18]94, Rogers & BINGHAM; 1 worker, Shillong, x.1976. **Nepal**: 1 worker, Lumleek, 1989; 12 workers, Ghasa-Tukhe, Larjung, 16 km SW Jomosom, 28° 41' N, 83° 37' E, 2550 m, 1.xii.1988, No. 9629, Ward. **Bhutan**: 4 workers, Gogona, 3100 m, 10–12.vi.1972 (MHMB – Bhutan Expedition, 1972); 9 workers, Nobding, 41 km O Wangdi Ph., 2800 m (MHMB – Bhutan

Expedition, 1972); 5 workers, Wangdi Phodrang, 1300 m, Roder & Caminada. **Pakistan:** 6 workers, Shagram, Khagan valley, 2200–2750 m, 14.viii.1994, Dakatra; 3 workers, Kalam, 2300 m, 12.viii.1994, Dakatra; 2 workers, Changla Gali, between Muree et Nathia Gali, 2200 m, 16.viii.1994, Dakatra; 8 workers, Naran, 31.v.1983, Brancucci; 9 workers, Shogram, 3.v.1983, No. 37c, Brancucci; 13 workers, Maduglarht, 27.v.1983, Brancucci. **Afghanistan:** 2 workers, Lalma, vi.1988, Klapperich; 3 workers, 2 queens (alate), without locality, 25.vi.1952, Klapperich; 1 worker, Walang, Salangtal, 2550 m, Klapperich; 1 worker, Paghman, 16.vii.1951, Lindberg.

Distribution. Throughout the Himalaya and adjacent mountains: Bhutan, Sikkim, Nepal, Karakorum, Pakistan and Afghanistan.

Notes. The original labels of the type series (4 workers and 1 queen), written in red ink in Menozzi's own hand, named this species "*M. amedeus-sabaudiae*"; it also was called this in the original description (MENOZZI 1939: 289) but unfortunately the misprinted *M. aimonis-sabaudiae* (hyphen now not recognised) occurs first (p. 286) and takes precedence. We studied a worker from MCZ with the labels: "Dusso (Braldo), 18–8–1929, 2400 m", "*M. amedeus-sabaudiae* Men. det." (red ink, written in Menozzi's own hand) and red printed label "M.C.Z. Paratypus 28766": this data excludes it from the type series according to the original paper (MENOZZI 1939: 289). Furthermore it is not *M. aimonissabaudiae*, we identified it as *M. wardi*. We also examined two workers of *M. dicaporiacoi* from MSNM labelled in Menozzi's own hand as "*M. dicaporiacoi*, typus". The data label of the first read "Sped. Karakorum, Shigar, 23.8.29, 2200 m" and the second "Sped. Karakorum, Askole (Braldo), V–29, 3100 m". The first fully agreed with Menozzi's original description, therefore we designated it as the lectotype of *M. dicaporiacoi*. However, the second specimen (from Askole) neither corresponds with type locality "Alchori, 2300 m" given in the original paper (MENOZZI 1939: 291) nor is it actually *M. dicaporiacoi*; we identified it as *M. wardi*. Possibly there is another specimen in MSNM from "Alchori, 2300 m" that will be a paralectotype of *M. dicaporiacoi*.

The main character that Menozzi used to separate *M. dicaporiacoi* from the other species of the *rugosa*-group was its shorter propodeal spines and eyes situated distinctly anterior to the mid-point of the sides of the head. But, the length of the propodeal spines is quite variable in many of the species, and the eyes of *M. aimonissabaudiae* are also anterior to the mid-length of the head (measured from anterior point of the clypeus). After examining the rich material of *M. aimonissabaudiae* we could find no distinguishing characters for *M. dicaporiacoi* and therefore considered these names as synonyms. The most similar species to *M. aimonissabaudiae* is *M. hecate* WEBER, from which it differs by its relatively shorter propodeal spines and less multidentate mandibles (mandibles of *M. hecate* have 10–13 teeth). It clearly differs from *M. rugosa* by the presence of coarse reticulation on posterior and lateral parts of the head dorsum (see Key and Figs 31 and 33).

A little is known about the ecology of *M. aimonissabaudiae*: it inhabits both natural and disturbed habitats, including fields and parks; it prefers relatively wet places and is quite common in irrigated fields; however, it is most abundant in semi-natural habitats where nests have been found in open grasslands with/or without shrubs, and in deciduous and coniferous forests, where it nests both in the ground and in rotten wood (P. WARD pers. comm.). *M. aimonissabaudiae* is found at altitudes between 1300 and

3450 m and based on literature records and collections, it appears to be one of the commonest of the Himalayan *Myrmica* species.

***Myrmica hecate* WEBER stat.nov.**

Myrmica smythiesi subsp. *hecate* WEBER, 1947, Ann. ent. Soc. Am. 40: 461. **Lectotype**, worker (MCZ): [India], Himalaya, Darjeeling, Botanical gardens, 6900', 7.viii[19]09, No. 8609–18, Paxia, (examined, designated here). **Paralectotype**, worker (broken) (MCZ): Darjeeling, 6000', 24.x[19]09, No. 8607–19, Brunetti, (examined, designated here).

Myrmica smythiesi subsp. *hecate*: BOLTON, 1995, New general catalogue ants: 279.

Myrmica hecate: RADCHENKO & ELMES, Vest. Zool. 34: (*in press*) (description queen and male).

Other material examined (NHMB, BMNH, IZK, Elmes, Schulz, Collingwood): **India**: 3 workers, Himchal Pradesh, Manali, Oalti Kumal, Boucek; 1 worker, Himchal Pradesh, Chopal-Khangna Nallah, 2250 m, 7.v.1977, Wittmer & Brancucci; 1 queen, 2 males, Himchal Pradesh, Kullu Valley, 2–4 km SW Rothang La Pass, 3400–3700 m, 10.x.1996, No. 422, 423, Schulz & Vock; 5 workers, Darjeeling, 7000', 1–10.iii.[1]924, Hingston; 2 workers, W. Bengal, Darjeeling, vii.1957, Krauss; 3 workers, Darjeeling, Tiger Hills, 12.v.1976, Wittmer & Baroni Urbani; 3 workers, Darjeeling, Bhara patee Lepong, 1800–1900 m, 11.v.1976, Wittmer & Baroni Urbani; 1 worker, Darjeeling, Ihepi, 1300–1400 m, 17.v.1975, Wittmer; 7 workers, Kashmir, Yusmarg, 2300–2400 m, 5.vii.1976, Wittmer; **Nepal**: 10 workers, Lumle, 1988, COLLINGWOOD; 14 workers, Baira Bali von Katmandu, 28.v.1976, Wittmer & Baroni Urbani; 6 workers, 1 queen, Daman, 2400 m, 4.vi.1976, Wittmer & Baroni Urbani.

Distribution. Himalaya: Sikkim, Nepal, Himachal Pradesh.

Notes. *M. hecate* most resembles *M. aimonissabaudiae* (see above). It has been taken at altitudes between 1300 and 3700 m., but nothing more is known about its ecology.

***Myrmica ereptrix* BOLTON**

Myrmica ereptrix BOLTON, 1988, Syst. Ent. 13: 2. **Holotype**, queen (BMNH): India: Kashmir, Gulmarg, 20.vii.1986, 2800 m, Williams (examined).

Myrmica ereptrix: BOLTON 1995, New general catalogue ants: 279.

Notes. *Myrmica ereptrix* is a socially-parasitic species with conspicuous, well developed, large ventral lobes on the petiole and postpetiole, that is known only from the single holotype queen. BOLTON (1988) gave *M. rugosa* as the host species. However, after resolving the confusion of nomenclature in the *rugosa*-complex (see above) we determined the host as *M. aimonissabaudiae* (confirmed by examination of the original material in BMNH). Bolton placed *M. ereptrix* in the *rugosa*-group, with its host, because studies of other socially parasitic *Myrmica* species suggest that the parasites are probably closely related to their hosts. We agree with this view.

***cachmiriensis*-complex**

We have grouped 3 species together in this complex. However, males of *M. ordinaria* are unknown and it is possible that species might be transferred to another species-group once males are found and described.

***Myrmica cachmiriensis* FOREL stat.nov.**

Myrmica smythiesii r. *cachmiriensis* FOREL, 1904, Revue suisse zool. 12: 23. **Lectotype**, worker and **paralectotypes**, 2 workers (NHMG): [India], "Kashmir, Sind Valley, 9500' (Wroughton)", "*M. smythiesii* v. *kashmiriensis* (Sic!) FOREL, type" (examined, designated here).

Myrmica smythiesii r. *cachmiriensis*: RUZSKY, 1905, trudy Obshch. Estest. imp. Kazan. Univ. 38: 661 (distribution).

Myrmica smythiesii subsp. *cachmiriensis*: EMERY, 1921, Genera Insectorum 174A: 41 (catalogue).

Myrmica smythiesii subsp. *cachmiriensis*: MENOZZI, 1939, Atti. soc. ital. Sci. nat. 78: 292 (key and description of male).

Myrmica smythiesii subsp. *cachmiriensis*: WEBER, 1947, Ann. ent. Soc. Am. 40: 457 (translation of original description to English).

Myrmica smythiesii subsp. *cachmiriensis*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (catalogue).

Myrmica smythiesii subsp. *cachmiriensis*: BOLTON, 1995, New general catalogue ants: 278.

M. smythiesii r. *cachmiriensis* var. *lutescens* FOREL, 1904, Revue suisse zool. 12: 23 (unavailable name).

M. smythiesii r. *cachmiriensis* var. *lutescens*: RUZSKY, 1905, Trudy. Obshch. Estest. imp. Kazan. Univ. 38: 661 (unavailable name) (distribution).

M. smythiesii r. *cachmiriensis* var. *lutescens*: FOREL, 1906, Bull. Soc. vaud. Sci. nat. 42: 87 (unavailable name) (distribution).

M. smythiesii r. *cachmiriensis* var. *lutescens*: EMERY, 1921, Genera Insectorum 174A: 412 (unavailable name) (catalogue).

M. smythiesii r. *cachmiriensis* var. *lutescens*: WEBER, 1947, Ann. ent. Soc. Am. 40: 458 (unavailable name) (translation of original description to English).

M. smythiesii r. *cachmiriensis* var. *lutescens*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (unavailable name) (catalogue).

M. smythiesii var. *lutescens*: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 292 (first available name) (key, distribution and description of queen). **Lectotype**, worker and **paralectotypes**, 2 workers (NHMG): [India], "Cachmire (Smythies)", *M. smythiesii* For. r. *cachmiriensis* For. v. *lutescens* For., type" (examined, designated here), **syn.nov.**

M. smythiesii subsp. *lutescens*: BOLTON, 1995, New general catalogue ants: 281 (*M. smythiesii* subsp.).

Other material examined (NHMB, BMNH, IZK, Elmes, Rigato, Ward): **India**: 3 workers, Kashmir, Aru, 34° 05' N, 75° 71' E, 2500 m, v.1978, Weare; 3 workers, Kashmir, Pahalgam, 2100 m, 10–17.viii.1992, Dakatra; 10 workers, Kashmir, Pahalgam, 34° 02' N, 75° 19' E, 2190 m, 27.vii.1978, No. 3012, Ward; 3 workers, Kuln, 34° 16' N, 75° 09' E, 2100 m, 8.viii.1978, No. 3050–7, Ward; 10 workers, 7 queens, 3 males, Kashmir, Daksum, 2400–2700 m, 9–13.vii.1976, Wittmer; 6 workers, Kashmir, Gumlarg-Tangmarg, 2300–2650 m, 3.vii.1976, Wittmer; 1 worker, Kashmir, Tsumarg, 2300–2400 m, 3.vii.1976, Wittmer; **Pakistan**: 3 workers, Kagan Valley, Shogran, 2300–2600 m, 14.viii.1994, Dakatra; 4 workers, Changlu Gali, between Mure and Nathia Gali, 2200 m, 16.viii.1994, Dakatra; 3 workers, Sobodan Gali (Bagh), 2300 m, 19.viii.1994, Dakatra.

Distribution. NW Himalaya, Karakorum.

Notes. The type specimens of var. *lutescens* differ from the types of *M. cachmiriensis* only by the lighter yellow or somewhat orange-yellow colour of the body. However, among the other non-type material studied we found that the colour of specimens, even from the same nest, varied from pale yellow to yellowish-red. Consequently, we consider var. *lutescens* to be a junior synonym of *M. cachmiriensis*. MENOZZI (1939: 292) recorded the following additional localities for *M. cachmiriensis*: Chokpiong, 2600 m; Hoto, 2900 m; Askole, 3100 m (valley Bradlo); Smiuntsa, 3200 m; Tsok, 3490 m (valley Punmah); Kagan, 2000 m (all are in North-East Pakistan, Karakorum). MENOZZI labelled a specimen from one of these locations (Askole, 3100 m, valley Bradlo) as a type of *M. dicaporiacoi* but we identified this specimen as *M. wardi* (see notes to *M. aimonissabaudiae*). Therefore we suspect that the material determined by MENOZZI as *M. cachmiriensis* (loc. cit.) will after detailed examination, be shown to contain several species from the *cachmiriensis*-complex. Furthermore, EIDMANN (1942) noted *M.*

cachmiriensis from West China and Tibet (alt. 1000–3600 m). We suspect that a revision of Eidmann's material would show this identification to be incorrect.

M. cachmiriensis has been found at altitudes between 2100 and 3500 m, but its ecology is poorly known. MENOZZI (1939) noted this species was found on irrigated fields in oases in arid territories, whereas P. WARD (*pers. com.*) found it in open pine and fir-pine forests. Alate queens and males have been collected in mid July.

Myrmica wardi RADCHENKO & ELMES

Fig. 36

Myrmica wardi RADCHENKO & ELMES, 1999, Vest. Zool. 33: 38. **Holotype**, worker (BMNH): **India**: Kashmir, Ladakh, Leh, 34° 11' N, 77° 35' E, 3450 m, No. 3094, 21.viii.1978, Ward. **Paratypes** (BMNH, NHMB, MCZ, IZK, Rigato, Schulz, Ward, Elmes, Mei): **India**: 6 workers from the nest of the holotype, Ward; 6 workers, 1 queen, Kashmir, Pahalgam, 34° 02' N, 75° 19' E, 2190 m, No. 3003, 27.vii.1978, Ward; about 100 workers, 2 males, Kashmir, Lidderwat, 34° 09' N, 75° 15' E, 2700 m, No. 3015, 3018c, 3023, 3029, 30.vii.1978, Ward; 1 worker, 1 queen, Kashmir, Kulan, 34° 16' N, 75° 09' E, 2100 m, No. 3050–10, 3050–12, 8.viii.1978, Ward; 29 workers, 1 queen, Kashmir, Ladakh, Panikhar, Suru R., 34° 07' N, 75° 57' E, No. 3077, 3078, 17.viii.1978, Ward; 3 workers, Kashmir, Ladakh, Leh, 34° 11' N, 77° 35' E, 3450 m, No. 3090, 21.viii.1978, Ward; 4 workers, Kashmir, Sonamarg, 34° 18' N, 75° 18' E, 2700 m, No. 3102, Ward; 3 workers, Himchal Pradesh, vic. Theong, 25 km E Shimla, 2400 m, No. 394, 29.ix.1996, Schulz & Vock; 3 workers, 2 queens, Himchal Pradesh, Kullu valley, 5–7 km SW Rothang La Pass, 2500–2900 m, No. 432, 1.x.1996, Schulz & Vock. **Pakistan**: 8 workers, Chitral Valley, between Dir and Lawari Pass, 2400 m, 11.viii.1994, Dakatra.

Other material examined (MSNM): **Pakistan**: 1 worker, Sped. Karakorum, Askole (Bradlo), v–[19]29, 3100 m (det. by Menozzi as *M. dicaporiaccoi*) [misidentification]; 1 worker, Dusso (Bradlo), 18.viii.1929, 2400 m (det. by Menozzi as paratype of *M. aimonissabaudiae*) [misidentification].

Distribution. Himalaya, Karakorum (India and Pakistan).

Notes. Based on the identifications made by some of the earlier myrmecologists, we guess that this species often has been confused with other Himalayan *Myrmica* species. It most resembles *M. cachmiriensis* from which the workers differ by a much denser longitudinal rugulosity on the head dorsum with densely punctured surface between the rugae, and darker colour of the body.

A little is known about its ecology (P. WARD, *pers. comm.*). Ants were collected at altitudes of 2190–3450 m in the same regions of Kashmir as *M. rhytida*. However, *M. wardi* is distinctly associated more with open woodland and lives at lower altitudes than *M. rhytida* (average 2700 m compared with 3600 m). It was found in meadows with sparse trees – willow, *Prunus*, *Acer* and fir species, also among woody shrubs with *Rosa* sp., and in stony grasslands and pastures having a low sward. The few nests that were found were built in the soil. Most specimens were collected while foraging over low vegetation in the manner of the European *Myrmica rubra* (L.), which it could resemble in other habits.

Myrmica ordinaria RADCHENKO & ELMES

Fig. 39

Myrmica ordinaria RADCHENKO & ELMES, 1999, Vest. Zool. 33: 41. **Holotype**, worker (BMNH): **India**: Kashmir, Seven Springs. 29.vii.[19]86, Williams. **Paratypes** (BMNH, NHMB, IZK, Rigato, Elmes): 23 workers, 1 queen (dealate) with the same label (probably same nest) as holotype. 6 workers, **Pakistan**, Kalam, 2300 m, 12.vii.[19]94, Dakatra.

Distribution. Himalaya, Karakorum (known only from the type series).

Notes. Based on workers and queens, *M. ordinaria* is closely related to *M. wardi* and *M. cachmiriensis*. Specimens differ from *M. wardi* by having a less densely rugulose and very finely punctured head dorsum, and from *M. cachmiriensis* by the longer heads of the queens (CI = 1.27 versus 1.12–1.20), relatively longer sub-decumbent pilosity on the sides of the head and the much darker body colour of the workers (see also Key). Males and ecology are unknown.

smythiesii-group

The characteristics of workers of species which belong to this group are very similar to those of the *rubra*-group, especially the Middle Asian species (RADCHENKO 1994a,b). In particular, the frontal carinae are short, almost straight but curving outwards to merge with rugae which surround the antennal sockets. Antennal scapes of the males are relatively long (0.83–1.0) but distinctly shorter than in species from the *rubra*-group (SI2 1.23–1.36).

Myrmica smythiesii FOREL

Figs 29–30

Myrmica smythiesii FOREL, 1902, Revue suisse zool. 10: 226. **Lectotype**, worker (NHMG): “Himalaya (Smythies)”, “*M. smythiesii* FOREL”, “LX/1, LX/12” (examined, designated here). **Paralectotypes**: 2 workers (NHMG) with same labels as lectotype; 1 worker (MCZ), “*M. smythiesii* FOREL, Himalaya, 7000–12000’ (Smythies)”, “M.C.Z type 20533” (examined, designated here).

Myrmica smythiesii: BINGHAM, 1903, Fauna of British India 2: 269 (key and distribution).

Myrmica smythiesii: FOREL, 1904, Revue suisse zool. 12: 22 (distribution).

Myrmica smythiesii: EMERY, 1908, Dt. ent. Z. 1908: 166 (key and distribution, part, not material from Middle Asia and Siberia).

Myrmica smythiesii: EMERY, 1921, Genera Insectorum 174A: 411 (catalogue, part, not material from Middle Asia and Siberia).

Myrmica smythiesii: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 295 (key).

Myrmica smythiesii: WEBER, 1947, Ann. ent. Soc. Am. 40: 456 (redescription of workers, part, not material from Middle Asia and Siberia).

Myrmica smythiesii: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 129 (catalogue). *Myrmica smythiesii*: BOLTON, 1995, New general catalogue ants: 383.

Myrmica smythiesii: RADCHENKO & ELMES, Vest. Zool. 34 (*in press*) (description queen and male).

not RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 659 [misidentification].

M. smythiesii subsp. *himalayana* WEBER, 1947, Ann. ent. Soc. Am. 40: 460. **Lectotype**, worker and **paralectotypes**, 2 workers (MCZ): India, Simla, Wroughton (examined, designated here) **syn.nov.**

M. smythiesii subsp. *himalayana*: BOLTON, 1995, New general catalogue ants: 279.

Other material examined (NHMB, UMO): **Nepal**: 2 workers, Gompa, bei Tarahot, 3400 m, 5.iv.1973, Martens. **India**: 2 queens, Yangti, Almora UP, 12300’, 18.vii.1923, No. 52, 53, Parker; 2 workers, Simla Hills, Kulala 8000’, under stone, 14.v.[19]24, No. 58, 59, Benson; 4 workers, Simla India, No.18.

Distribution. Himalaya, Himachal Pradesh and Nepal.

Notes. The correct name of this species is *M. smythiesii* but many other authors have used the more logical spelling *M. smythiesi*. This species was believed to be much more widespread and common than it actually is, probably because many earlier authors, including FOREL, had too wide a definition of *M. smythiesii*, attributing to it species from

several species groups. For example, FOREL (1904) included as *M. smythiesii* material from the Far East ("Middle Ussuri"); EMERY (1908 and 1921) indicated that its range extended from the Himalaya to the "East Turkestan" (i.e. Tien-Shan and Pamir Mts.), Altai and East Siberia, while RUZSKY (1905) recorded it from the Middle Asian mountains. However, RUZSKY's "*M. smythiesii*" is *M. dshungarica* RUZSKY, 1905 (RADCHENKO, 1994b). We suggest that *M. smythiesii* is restricted to the Himalaya at altitudes between 2100 and 3650 m, where it probably is quite rare: only a few Himalayan localities are recorded in the literature and on collection labels. The subspecies *himalayana* was distinguished from *M. smythiesii* by its much shorter propodeal spines (after WEBER, 1947: 960). We have studied the types of both and have found that the length of the propodeal spines overlap and vary greatly in both forms (ESLI 0.18–0.24 in *M. smythiesii* versus 0.15–0.19 in subsp. *himalayana*). As we could find no other real differences we consider subsp. *himalayana* to be a junior synonym of *M. smythiesii*.

Ecology and males are unknown. When males are discovered we suspect that they will have relatively long antennal scapes, like *M. fortior*, *M. dshungarica* and some closely related Tibetan forms such as "subspecies" *bactriana* RUZSKY, 1915, *exigua* RUZSKY, 1915.

Myrmica fortior FOREL stat.nov.

Figs 26–28

Myrmica smythiesii var. *fortior* FOREL, 1904, Revue suisse zool. 12: 22 (part, not material from Far East).

Lectotype, worker and **paralectotypes**, 2 workers (NHMG): "India, Sind Valley, 6500', Kashmir (Wroughton), var. *fortior* FOREL" (examined, designated here).

Myrmica smythiesii var. *fortior*: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 660 (distribution in part, not material from Far East).

Myrmica smythiesii var. *fortior*: FOREL, 1906, Bull. Soc. vaud. Sci. nat. 42: 87 (distribution).

Myrmica smythiesii var. *fortior*: EMERY, 1908, Dt. ent. Z. 1908: 168 (key and distribution in part, not material from Far East).

Myrmica smythiesii var. *fortior*: EMERY, 1921, Genera Insectorum 174A: 41 (catalogue, part, not material from Far East).

Myrmica smythiesii var. *fortior*: MENOZZI, 1939, Atti Soc. ital. Sci. nat. 78: 295 (key).

Myrmica smythiesii var. *fortior*: WEBER, 1947, Ann. ent. Soc. am. 40: 460 (translation of original description to English).

Myrmica smythiesii var. *fortior*: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (catalogue).

Myrmica smythiesii subsp. *fortior*: BOLTON, 1995, New general catalogue ants: 279.

Myrmica fortior: RADCHENKO & ELMES, Vest. Zool. 34: (in press) (description of queen and male).

Other material examined (BMNH, NHMG, NHMB, IZK, Rigato, Elmes, Ward): **India**: 31 workers, Kashmir, Sonamarg, 2700 m, 5.viii.1986, Williams; 4 workers, Kashmir, Aru, 34° 05' N, 75° 17' E, May 1978, 2500 m, Weare; 2 workers, Kashmir, Daksum, 2400–2700 m, 1–17.vii.1976, Wittmer; 13 workers, 1 queen (dealate), Kashmir, Pahalgam, 34° 02' N, 75° 19' E, 2100 m, 27.vii.1978, No. 3010, 3011, Ward; 5 queen (alate), 1 male, Kashmir, Lidderwatt, 34° 09' N, 75,15 E, 2700 m, 30.vii.1978, No. 3018, 3018 B (male), Ward; 4 workers, Shankarachayra, 7.viii.1961, from soil, No. 42; Sorale San, Kangwan-do, 22.vii.1998, Dakatra.

Distribution. Himalaya, Kashmir.

Notes. Workers of *M. fortior* are superficially very similar to those of several oriental species belonging to the *ruginodis*-complex. This could explain FOREL's (1904a) mistake (repeated by RUZSKY 1905) when he referred material from the Far East to *M. fortior*. We are sure that those specimens from the Far East must be *M. ruginodis* NYLANDER,

1846 or related species. *M. fortior* workers differ from species belonging to the *ruginodis*-complex by having a distinctly prominent and anteriorly pointed clypeus. Although males have quite long antennal scapes, they are relatively shorter than those of males belonging to the *ruginodis*-complex (SI2 0.83–1.0 versus 1.23–1.36). *M. fortior* differs from *M. smythiesii* by a suite of minor characters including the shape and sculpture of the petiole and postpetiole, slightly longer propodeal spines and slightly larger body size. The ecology of *M. fortior* is poorly known. It has been found at altitudes between 2000 and 2700 m, where it nested in the soil and under stones, in open pine wood and open rocky pasture, at the edge of spruce-fir grove (P. WARD *pers. comm.*).

Myrmica wittmeri RADCHENKO & ELMES

Myrmica wittmeri RADCHENKO & ELMES, 1999, Vest. Zool. 33: 38. **Holotype**, worker (NHMB): India, Him.[machal] Prad.[esh], Mahri, 3000–3200 m, 15.v.1977, Wittmer & Brancucci. **Paratypes** (NHMB, IZK, Rigato, Schulz, Elmes): **India**: 3 workers (one without head), with the same label as holotype; 6 workers, Himchal Pradesh, Kullu valley, La Pass, 3400–3700 m, 2.x.1996, No. 420, 422, Schulz & Vock. **Pakistan**: 3 workers, Kalam, 2300 m, 12.vii.[19]94, Dakatra.

Distribution. Himalaya, Karakorum (India and Pakistan).

Notes. *Myrmica wittmeri* is known only from the type series. Queens and males are unknown. It distinctly differs from the other species of the *smythiesii*-group by a much darker colour and a reduced sculpture on the alitrunk. Its ecology is unknown.

inezae-group

This group contains three conspicuous species which combine features of both the *ritae*- and *rugosa*-groups: the Himalayan species *M. inezae* and *M. rigatoi* (previously placed in the *ritae*-group, see RADCHENKO & ELMES 1999b) and an as yet undescribed species from the West China. Workers of these species differ from most other *Myrmica* by possessing a long petiole with a very long and thin peduncle, long propodeal spines, legs and antennal scapes, and slender bodies. While these are also all features of *ritae*-group species, the *inezae*-group clearly differs from them by not having the medially notched anterior clypeal margins, and the apically pointed propodeal lobes (features which characterize the *ritae*-group). The intermediate position of *M. inezae* between *ritae*- and *rugosa*-groups was also discussed by FOREL (1902).

Myrmica inezae FOREL

Figs 15–16

Myrmica inezae FOREL, 1902, Revue suisse zool. 10: 226. **Holotype**, worker (NHMG): Himalaya, Pahmarhi, (Schurr) (examined).

Myrmica inezae: BINGHAM, 1903, Fauna of British India 2: 268 (key and distribution).

Myrmica inezae: EMERY, 1921, Genera Insectorum 174A: 37 (catalogue).

Myrmica inezae: WEBER, 1947, Ann. ent. Soc. Am. 40: 467 (translation of original description to English).

Myrmica inezae: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 126 (catalogue).

Myrmica inezae: BOLTON, 1995, New general catalogue ants: 279.

Myrmica inezae: RADCHENKO & ELMES, Vest. Zool. 34: (*in press*) (description of queen).

Other material examined (NHMB, BMNH, IZK, Elmes, Schulz): **India**: 3 workers, Himchal Pradesh, Manali, 2000–3000 m, 14.v.1977, Wittmer; 2 workers, H[imachal] P[radesh], Mussorie, 1300–2200 m, 27.vi.1976, Wittmer; 6 workers, Himchal Pradesh, Chopal, 2400–2750 m, 2.v.1977, Wittmer; 1 worker, Himchal Pradesh, Manali, 1826 m, 10.x.1979, Wittmer; 7 workers, 1 queen (dealate), Himchal Pradesh, vic, Theong, 25 km E Shimla, 2400 m, 29.ix.1996, No. 399, Schulz & Vock.

Distribution. Probably central Himalaya (recorded only from Himachal Pradesh, India).

Notes. Although this species was originally described from a single worker, it is easily discriminated from all known *Myrmica* species by a combination of very unusual, transversal coarse rugosity on the alitrunk dorsum, long propodeal spines and a long petiole with very long and thin peduncle (see also Figs 15, 16). Males and ecology are unknown.

Myrmica rigatoi RADCHENKO & ELMES

Figs 17–18

Myrmica rigatoi RADCHENKO & ELMES, 1998, Vest. Zool. 32: 18. **Holotype**, worker (Rigato): Pakistan: Changla Gali (between Murree and Nathia Gali), 2200 m, 16.viii.1994, Dakatra.

Other material examined (NHRM): Pakistan: 1 worker, Hazara Durgo Gal., 2300 m, 17.iv.1984, Zoja.

Distribution. Pakistan.

Notes. Originally *M. rigatoi* was wrongly placed in the *ritae*-group (RADCHENKO & ELMES 1998). It clearly differs from *M. inezae* by the absence of transversal sculpture on the alitrunk. Queens, males and ecology are unknown.

pachei-group

This group comprises only two species – *M. pachei* and *M. villosa*. The workers of these differ from those from the *rugosa*-group by having a generally much less coarse sculpture of the body, and especially by a dense fine transverse rugulosity on the promesonotum. Also, males of *M. pachei* have long antennal scapes in contrast to males from the *rugosa*-group.

Myrmica pachei FOREL

Myrmica pachei FOREL, 1906, Bull. Soc. vaud. Sci. nat. 42: 79. **Lectotype**, worker (NHMG): NE Nepal, Tseram, 3600 m, Pache (examined, designated here). **Paralectotypes**: 2 workers (NHMG) and 1 worker (MCZ) with same label as lectotype (examined, our designation). Queens and males (presumably same series as lectotype) in NHMG (not examined).

Myrmica pachei: EMERY, 1921, Genera Insectorum 174A: 38 (catalogue).

Myrmica pachei: MENOZZI, 1939, Atti Soc. ital. Sci. nat. 78: 293 (key).

Myrmica pachei: WEBER, 1947, Ann. ent. Soc. Am. 40: 467 (translation of original descriptions of workers, queens and males to English).

Myrmica pachei: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 128 (catalogue).

Myrmica pachei: COLLINGWOOD, 1970, Khumbu Himal. 3: 374 (distribution).

Myrmica pachei: BOLTON, 1995, New general catalogue ants: 281.

Other material examined (BMNH, NHMB, IZK, Martens, Elmes, Schulz): **Nepal**: 3 workers, Prov. Taplejung, upper Simbu Khola Valley, vic. Tseram, 3250–3350 m, 10–15.v.1998, Martens & Schawaller; 1

queen, Prov. Taplejung, Dhara und Alm Lasea, 3000–3300 m, 1.ix.1983, Martens & Schawaller. **Bhutan:** 10 workers, Nobding, 41 km O Wangdi, 2800 m. (NHMB – Bhutan Expedition, 1972); 10 workers, Kotoka-Gogona, 2600–3400 m (NHMB – Bhutan Expedition, 1972); 25 workers, 1 queen (dealate), Doriula, 3100 m, 6.vi.1972 (NHMB – Bhutan Expedition, 1972).

Distribution: Central and South-East Himalaya, Nepal to Bhutan.

Notes. The workers of *M. pachei* clearly differ from all other *Myrmica* species (except *M. villosa*) by the dense, fine transversal rugulosity of the alitrunk dorsum. The antennal scapes of the males are long: “... dépassent l’occiput de près d’1/5 de leur longueur ...” (FOREL 1906: 81). It differs from *M. villosa* by shorter, more straight and not so abundant hairs on the body, a darker colour and by much more dense sculpture on the alitrunk (see also Key and Figs 19–21). The ecology of this unusual species is unknown.

Myrmica villosa RADCHENKO & ELMES

Figs 19–20

Myrmica villosa RADCHENKO & ELMES, 1999, Vest. Zool. 33: 31. **Holotype**, worker (NHMB): Bhutan: Diechli Paka, 5 km O Pelela, 3300 m, 19–20.vi. (NHMB – Bhutan Expedition, 1972). **Paratypes** (BMNH, NHMB, IZK, Elmes): 15 workers, 1 queen (dealate – NHMB), with the same label as holotype.

Distribution. Bhutan.

Notes. This species is known only from the type-series collected in Bhutan. *M. villosa* is closely related to *M. pachei* but differs from it mainly by a more dense sculpture of the head dorsum, by more abundant, long, thin, fine, curved body hairs and longer hairs on the legs, and by a lighter coloured alitrunk. Queens also differ by having non-striated petiolar and postpetiolar nodes and by a less strongly sculptured alitrunk. The males and ecology are unknown.

tibetana-group

Workers of the species belonging to this group are characterized by having frontal carinae that are curved at their anterior third, frontal lobes which are relatively wide and sub-square (see Fig. 10) with $FLI > 1.30$, and antennal sockets that are not surrounded by concentric rugae. By these features they resemble species from the *scabrinodis*-group, although in that group the frontal carinae curve from the mid-length and are S-shaped. Males have short antennal scapes like those of the *scabrinodis*-group.

Myrmica tibetana MAYR

Fig. 12

Myrmica tibetana MAYR, 1889, Trudy russk. ent. Obshch. 24: 279. **Lectotype**, worker (MNHU): “Tibet” (previously also labelled as paratype) (examined, designated here).

Myrmica tibetana: RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 661 (distribution).

Myrmica tibetana: EMERY, 1908, Dt. ent. Z. 1908: 181 (key and distribution).

Myrmica tibetana: RUZSKY, 1915, Ezheg. zool. Muz. 20: 310 (description of male).

Myrmica tibetana: EMERY, 1921, Genera Insectorum 174A: 42 (catalogue).

Myrmica tibetana: WEBER, 1947, Ann. ent. Soc. Am. 40: 465 (redescription of worker).

Myrmica tibetana: COLLINGWOOD, 1961, Vidensk. Meddr. dansk. naturh. Foren. 123: 56 (distribution).

Myrmica tibetana: BOLTON, 1995, New general catalogue ants: 284.

Distribution. Tibet, probably not present in Afghanistan.

Notes. *M. tibetana* probably does not belong to Himalayan *Myrmica* fauna, as defined in this paper. It is a Tibetan species that was recorded from East Afghanistan (Nurestan) by COLLINGWOOD (1961). However, no other authors have noted this species from the west of the Himalaya, nor have we found any *M. tibetana* among the Himalayan *Myrmica* material studied, or from other material from the mountains of Middle Asia. We suggest that probably, Collingwood's identification was wrong and that his specimens might have been the closely related *M. tenuispina*, which differs by longer propodeal spines.

Myrmica tenuispina RUZSKY, 1905

Figs 10–11

Myrmica rubra r. *laevinodis* var. *tenuispina* FOREL, 1904, Ezheg. zool. Muz. 8: 374 (unavailable name).

Myrmica rubra r. *laevinodis* var. *tenuispina*: EMERY, 1908, Dt. ent. Z. 1908: 170 (unavailable name) (key and distribution).

Myrmica rubra r. *laevinodis* var. *tenuispina*: EMERY, 1921, Genera Insectorum 174A: 39 (unavailable name) (catalogue).

Myrmica rubra r. *laevinodis* var. *tenuispina*: KUZNETZOV-UGAMSKY, 1927, Ent. obozr. 21: 193 (unavailable name) (distribution).

Myrmica laevinodis var. *tenuispina* RUZSKY, 1905, Trudy Obshch. Estest. imp. Kazan. Univ. 38: 670 (first available use of name) (key and distribution). **Lectotype**, worker (ZMMU): "Tabi dara-Zagyrdesht, E. Bukhara, 17.vi.[18]97, Kaznakov" (examined, designated here). **Paralectotypes** (ZMMU): 5 workers with same label as lectotype; 1 worker, "Tash-Kurgan, Darvaz, E. Bukhara, 22.vii.[18]97, Kaznakov" (examined, our designation).

Myrmica laevinodis var. *tenuispina*: WEBER, 1947, Ann. ent. Soc. Am. 40: 455 (redescription of workers).

Myrmica tenuispina: ARNOLDI, 1976, Zool. Zh. 55: 551 (raised to species and description of male).

Myrmica tenuispina: TARBINSKY, 1976, Muravii Kirgizii: 25 (key, ecology and distribution).

Myrmica tenuispina: DLUSKY, Soyunov & Zabelin, 1990, Muravii Turkmenistana: 184 (key, ecology and distribution).

Myrmica tenuispina: BOLTON, 1995, New general catalogue ants: 284.

Myrmica tenuispina: RADCHENKO & ELMES, Vest. Zool. 34: (in press) (description of queen).

Other material examined (ZIP, ZMMU, NHMB, IZK). **Tadzhikistan**: 5 workers, Gul'dara, Kashka-Dar'ya, 2400 m, 11.v.1949, Arnoldi; 1 worker, Gissar range, Anzobsky pass, 2800 m, 9.viii.1970, Yanushev; **Afghanistan**: 12 workers, 4 queens, Badakshan, Sarekanda, 4100 m, 18.vii.1953, Klaepperich.

Distribution. Afghanistan, Middle Asian mountains and plains (on the plains it has been found only in the Syrdar'ya and Amu Dar'ya. river valleys).

Notes. This species is mainly associated with the mountains of Middle Asia. However, the collection data for Afghanistan are valid and it should be included as a Himalayan *Myrmica* species. In mountains it lives on subalpine meadows at altitudes between 2700 and 4100 m, where it nests in the soil and under stones.

kurokii-group

This group contains large, robust *Myrmica* species that are widely distributed from Tibet and Himalaya to Japan. The workers are characterized by antennal scapes without carinae or lobes at the base, and by frontal carinae which curve outwards to merge with the rugae surrounding the antennal sockets (features shared with the *rubra*-group). They differ from the *rubra*-group however, by having antennal scapes that are more strongly curved at their bases, by a massive petiole with very short peduncle, by a more dense but not coarse sculpture on the head dorsum, and by their generally larger size. The antennal scapes of the males are long, similar to those of the *rubra*-group species. We place at least 3 described species in this group: *M. kurokii* FOREL 1907, *M. helleri* VIEHMEIER, 1922 and *M. kozlovi*, and probably some new as yet undescribed species from West China. There are many unresolved taxonomic problems concerning this group which we will address elsewhere.

***Myrmica kozlovi* RUZSKY**

Fig. 24

Myrmica kozlovi RUZSKY, 1915, Ezheg. zool. Muz. 20: 502. **Lectotype**, worker (ZIP): "Tibet, afflux of the riv. Dza-Chu, Kam, basin of the riv. Golubaya, 12–13000', beginning of May [19]01, leg. Kozlov" (in Russian; here is Eastern Tibet, basin of the riv. Yangtse) (examined, designated here). **Paralectotypes** (ZIP, ZMMU): 8 workers with same labels as lectotype (examined, designated here).

Myrmica kozlovi: EMERY, 1921, Genera Insectorum 174A: 37 (catalogue).

Myrmica kozlovi: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 294 (key).

Myrmica kozlovi: WEBER, 1947, Ann. ent. Soc. Am. 40: 470 (translation of original description to English).

Myrmica kozlovi: COLLINGWOOD, 1970, Khumbu Himal. 3: 374 (distribution).

Myrmica kozlovi: RADCHENKO, 1994, Zool. Zh. 73: 42 (taxonomy and distribution).

Myrmica kozlovi: BOLTON, 1995, New general catalogue ants: 280.

Myrmica specularis DONISTHORPE, 1929, Ann. Mag. Nat. hist. 4: 446. **Holotype**, worker and **paratypes**, 4 workers (BMNH): "Tibetan side of the Mt. Everest: Tibet, Gautsa, 13000', 5.iv.1924, Hingston (examined) **syn.nov.**

Myrmica specularis: MENOZZI, 1939, Atti. Soc. ital. Sci. nat. 78: 293 (key).

Myrmica specularis: WEBER, 1950, Ann. ent. Soc. Am. 43: 224 (distribution).

Myrmica specularis: CHAPMAN & CAPCO, 1951, Mon. Inst. Sci. Tech. Asia 1: 130 (catalogue).

Myrmica specularis: BOLTON, 1995, New general catalogue ants: 283.

Other material examined (BMNH): **Tibet**: 2 workers, SE Tibet, Dzogang, 9–14000', 1–21.ix.1936, Tibet expedition, 1903. **India**: 7 workers, Sikkim, Khamba Jong, 15–16000', 15–30.vii.[19]03.

Distribution. Tibet; India (Sikkim), Nepal.

Notes. After studying the types and additional material of *M. kozlovi* and *M. specularis* we are convinced that these are the same species. *M. specularis* differs only by a somewhat darker head, a slightly more massive petiolar node and by slightly coarser and more regular rugosity of the petiole and postpetiole. *M. kozlovi* has been found at the highest altitudes recorded for any *Myrmica* species worldwide (4800 m) which probably accounts for it being the only *Myrmica* species that has crossed the Himalayan barrier to live on both the western and eastern slopes.

Species with an unresolved taxonomic position

We were unable to assign five species to any of the above or previously proposed groups of *Myrmica* species. Furthermore, each has characteristics that separate them from each other so that they can not be grouped together.

Myrmica brancuccii RADCHENKO, ELMES & COLLINGWOOD Fig. 9

Myrmica brancuccii RADCHENKO, ELMES & COLLINGWOOD, 1999: *in*: RADCHENKO & ELMES, 1999, Vest. Zool. 33: 30. **Holotype**, worker (BMNH): Nepal: Utrot, 13.v.[19]83, Brancucci. **Paratypes** (BMNH, NHMB, Collingwood, IZK, Rigato, Elmes): Nepal: 5 workers with same label (probably same nest) as holotype; 14 workers, Lawarai, 21.v.[19]83, Brancucci; 1 worker, Lumle, vi.[19]88, Collingwood. Pakistan: 9 workers, Chitral V., between Dir and Lavari Pass, 2400 m, 11.viii. 1994, Dakatra.

Distribution. Nepal, Pakistan.

Notes. The striato-punctuation on the first gastral tergite well discriminates *Myrmica brancuccii* from all other Eurasian *Myrmica* species. Workers are very variable in size so that this could be a relatively polymorphic species in comparison with other *Myrmica*. Known only from the type series, the ecology, queens and males are unknown.

Myrmica vittata RADCHENKO & ELMES Figs 13–14

Myrmica vittata RADCHENKO & ELMES, 1999, Vest. Zool. 32: 33. **Holotype**, worker (BMNH): Pakistan: Bumburet, 24.v.[19]83 (Brancucci). **Paratypes** (BMNH, IZK, Rigato, Elmes): 2 workers with same label as holotype; 2 workers, Pakistan: Kalam, 12.viii.1994, Dakatra.

Distribution. Pakistan.

Notes. *Myrmica vittata* can be discriminated from all the other Eurasian *Myrmica* species which have antennal scapes that are weakly curved at their bases and frontal carinae that are not curved, by the absence of rugae surrounding the antennal sockets and by the coarse, regular longitudinal rugosity of the head, alitrunk (including dorsum) and petiolar nodes. Known only from the type series. The queens, males and ecology are unknown

Myrmica williamsi RADCHENKO & ELMES Fig. 22

Myrmica williamsi RADCHENKO & ELMES, 1999, Vest. Zool. 33: 34. **Holotype**, worker (BMNH), India: Kashmir, Pantitop, 2000 m, 6.09.[19]86, Williams.

Notes. *M. williamsi* was described only from single worker because it was well separated from all the other Eurasian *Myrmica* that have antennal scapes that are weakly curved at their bases, and frontal carinae that slightly curve outwards to merge with the rugae which surround the antennal sockets, by a combination of very short propodeal spines and a most unusual sculpture of alitrunk (see Fig. 22 and also Key). Known only from a single specimen, nothing can be deduced about its distribution, ecology and sexual forms.

***Myrmica nitida* RADCHENKO & ELMES**

Fig. 23

Myrmica nitida RADCHENKO & ELMES, 1999, Vest. Zool. 33: 35. **Holotype**, worker (BMNH): India: Kashmir, 1 km NE Yehmer Pass, 34° 13' N, 75° 10' E, 3600 m, 6.viii.1978, No. 3044, Ward. **Paratypes** (BMNH, NHMB, Ward, IZK, Elmes): 9 workers from the same nest as holotype; 17 workers, 4 queens (alate), 2 males, India, Kashmir, Sanang, 2600–2750 m, Wittmer.

Distribution. India, Kashmir.

Notes. *Myrmica nitida* is known only from the type series. The males have long antennal scapes and it is probably most related to the *smythiesii*-group. However, we do not place it there because the frontal carinae of the workers do not curve outwards and do not merge with the rugae surrounding the antennal sockets. Also, the worker alitrunk appears smooth and shiny with only fine superficial striation on the sides. Such fine sculpture, combined with very short propodeal spines, well discriminate *M. nitida* from all other known Eurasian *Myrmica*.

***Myrmica rhytida* RADCHENKO & ELMES**

Figs 37–38

Myrmica rhytida RADCHENKO & ELMES, 1999, Vest. Zool. 33: 41. **Holotype** (BMNH): worker, India: Kashmir, Up. Kainthal Nar, 34° 00' N, 70° 45' E, 3750 m, No. 3061, 14.viii.1978, Ward. **Paratypes** (BMNH, NHMB, IZK, Rigato, Schulz, Ward, Elmes, Mei): **India**: 113 workers, 32 males, from the same nest as holotype; 3 queens, 4 males, Kashmir, 3 km NE Tar Sar, 34° 09' N, 75° 11' E, 3300 m, No. 3037, 2.viii.1978, Ward; about 200 workers, 10 queens (dealate), 5 males, Kashmir, Tar Sar, 34° 09' N, 75° 09' E, 3950 m, No. 3038, 3039, 3040, 3041, 3042, 4.viii.1978, Ward; 4 workers, 1 queen, 4 males, Kashmir, Wampet, 34° 04' N, 75° 37' E, 3700 m, No. 3057, 12.viii.1978, Ward; 1 male, Kashmir, Up. Kaintal Nar, Otto, 34° 00' N, 75° 45' E, 4200 m, No. 3068, Ward; 3 workers, Beastel, 20 km S Rhotang, 2800 m, No. J–23, 18.viii.1990, Heinze.

Distribution. India, Kashmir.

Notes. Superficially, particularly by the shape of the alitrunk, workers of *M. rhytida* appear very similar to species from the *cachmiriensis*-complex, but we do not place it there because the males have long scapes. The workers and queens of *M. rhytida* differ from those of *M. wardi*, *M. ordinaria* and *M. cachmiriensis* by the distinctly coarser rugosity of head dorsum, alitrunk, petiole and postpetiole.

A little is known about its ecology (P. WARD *pers. comm.*). It is fairly common in the same regions of Kashmir as *M. wardi*. However it was found at higher altitudes (mean 3600 m versus 2700 m) between 3130 and 4200 m. Nests were found in the soil (often under stones) and in rotten birch logs, in alpine meadows which often contained Juniper species, and at the edges of birch forests at the altitude where rhododendrons begin to appear. Ward noted *M. rhytida* tending root aphids in several of its nests. Foragers stays close to the soil surface and were never observed on plants. Such cryptic foraging behaviour is reminiscent of that of the northern European forms of *Myrmica lobicornis* NYLANDER, 1846.

***Myrmica petita* RADCHENKO & ELMES**

Myrmica petita RADCHENKO & ELMES, 1999, Vest. Zool. 33: 45. **Holotype**, queen (NHMB): India: Kashmir, Yusmar, 2300–2400 m, 6.vii.1976, Wittmer.

Notes. *M. petita* is known only from a single queen. It is unusually small, probably smaller than the queens of all known free-living *Myrmica* species, and differs in this respect from all the other known free-living queens from the Himalayan *Myrmica* fauna. Possibly, it is a social parasite (like *M. erepatrix*), but we think this is unlikely because it lacks any of the typical “parasitic” characters, such as reduced pectinate spurs, ventral lobes on the petiole and postpetiole, relatively wide postpetiole and general hairiness. Morphologically, it most resembles the workers of *M. wittmeri*, which has an unknown queen, differing only by the punctured surface of its head dorsum, and relatively longer propodeal spines. While it is not unusual for the sculpture of the heads of *Myrmica* queens to be “coarser” than that of their workers, we know of no *Myrmica* species where the propodeal spines of the queens are relatively longer than those of their workers. Thus we do not assume that this is the queen of *M. wittmeri*. The workers, males and ecology are unknown.

A key for the identification of workers of the Himalayan *Myrmica* species¹⁾

- 1 Anterior clypeal margin shallowly but distinctly notched medially (Figs 1, 3, 4, 6) Propodeal lobes more or less pointed apically (Figs 2, 5, 7, 8) .. 2
- Anterior clypeal margin rounded or pointed, never notched medially (Figs 10, 13, 26, 31, 33, 36, 37). Propodeal lobes rounded apically (Figs 11, 12, 14, 15, 17, 19, 21–25, 27, 29, 32, 34, 38, 39) 6
- 2(1) Head and alitrunk very coarsely rugose, surface between rugae on head dorsum smooth (Figs 1–3) 3
- Head and alitrunk much more finely rugulose or even striated, surface between rugulae on head dorsum distinctly punctured (Figs 4–8) 4
- 3(2) Temples without outstanding hairs or with only a few short ones, and genae without outstanding hairs (Fig. 1). Colour of head, alitrunk and pedicel from dark brown to black, gaster from reddish brown to dark brown, legs and antennal scape reddish brown *indica*
- Temples and genae with numerous, usually curved, outstanding hairs (Fig. 3). Colour of head, alitrunk and pedicel from reddish brown to dark brown, gaster from brownish yellow to dark brown, legs and antennal scape brownish red *urbanii*
- 4(2) Surface between rugulae on head dorsum finely punctured, more or less shiny; dorsum of alitrunk with irregular striae; petiolar and postpetiolar nodes with very fine superficial punctures or even smooth, shiny (Figs 4, 5) *collingwoodi*
- Surface between rugulae on head dorsum densely and coarsely punctured, dull; dorsum of alitrunk with reticulate sculpture; petiolar and postpetiolar nodes densely punctured, sub-mat (Figs 6–8) 5
- 5(4) Propodeal spines very long (ESLI 0.52–0.58), directed more or less backwards and slightly curved downwards, sub-parallel to dorsal surface

¹⁾ *M. erepatrix* BOLTON and *M. petita* RADCHENKO & ELMES are known only from the females and are not included to this key.

- of propodeum and slightly diverging (ESDI 0.76–1.06). Hind tibia relatively long (HTI = 1.05–1.20) and petiole relatively low and long (Fig. 7) *boltoni*
- Propodeal spines relatively shorter and straight (ESLI 0.44–0.47), directed upwards at an angle of about 45° and distinctly diverging (ESDI 1.26–1.31). Hind tibia relatively short (HTI = 1.06–1.08) and petiole relatively high and short (Fig. 8) *martensi*
- 6(1) Basal third of first gastral tergite distinctly punctato-striated (Fig. 9) *brancuccii*
- Whole gastral tergites smooth and shiny 7
- 7(6) Frontal carinae strongly curved in their anterior third and frontal lobes forming wide, sub-square frontal lobes (FLI > 1.30) (Fig. 10) 8
- Frontal carinae more or less straight and frontal lobes narrow (FLI < 1.15) (Figs 13, 26, 31, 33, 36, 37) 9
- 8(7) Propodeal spines long, thin and sharp (Fig. 11) *tenuispina*
- Propodeal spines short, dentiform but sharp (Fig. 12) *tibetana*
- 9(7) Antennal sockets not surrounded by rugae, head and alitrunk coarsely longitudinally rugose, without reticulation or punctation, surface between rugae appears smooth and shiny (Fig. 13). Petiolar and postpetiolar nodes concentrically rugose. Petiole with long peduncle and sharply concave anterior surface; alitrunk dorsum weakly convex, with very shallow metanotal groove (Fig. 14) *vittata*
- Antennal sockets always surrounded by concentric rugae or at least by striae (Figs 26, 31, 33, 36, 37). Body sculpture variable, but never with only coarse longitudinal rugae. Without the particular combination of petiole with concave anterior face, a long peduncle and shallow metanotal groove (Figs 15–25, 27–30, 32, 34, 35, 38, 39) 10
- 10(9) Petiole with very thin and long peduncle (PI1 > 1.65). Propodeal spines very long, thin, directed upwards at an angle about 45° (ESLI > 0.40) (Figs 15, 17) 11
- Petiole with much thicker and shorter peduncle (PI1 < 1.60). Propodeal spines shorter and stouter and usually directed posteriorly (ESLI usually < 0.40) (Figs 19, 21–25, 27, 29, 32, 34, 38, 39) 12
- 11(10) Alitrunk dorsum with coarse transversal rugosity, without reticulation (Fig. 16) *inezae*
- Alitrunk dorsum without transversal rugosity, only with sinuous rugae and coarse reticulation (Fig. 18, 35) *rigatoi*
- 12(10) Promesonotal dorsum with fine dense (never coarse) transversal rugulosity (Fig. 20) 13
- Promesonotal dorsum with more coarse longitudinal sinuous rugae, or with reticulation, or with reduced sculpture 14
- 13(12) Body with very abundant, long, curved hairs (Fig. 19). Colour lighter: head dorsum dark reddish brown, alitrunk and gaster brownish red. *villosa*

- Body with much less abundant, shorter hairs (Fig. 21). Colour relatively darker: whole body dark reddish brown *pachei*
- 14(12) Posterior part of the alitrunk, petiole and postpetiole with no rugae (only fine striation presents on the lower parts of mesopleurae and sides of propodeum), but very densely punctured, appearing matt. Surface of the anterior alitrunk very finely punctured but the promesonotal dorsum also coarsely reticulate and the sides of the pronotum with sinuous longitudinal rugulae. Propodeal spines short, dentiform but sharp. Body with sparse, straight, thick erect hairs (Fig. 22). Whole body brownish black, appendages dark brown *williamsi*
- Propodeum, mesopleurae, petiole and postpetiole never with only dense punctures. If punctures are present, they are between rugae. Usually whole alitrunk rugulose, rugose or reticulate (Figs 27, 29, 32, 34, 38, 39) and if the sculpture reduced, it either remains distinct (Fig. 25) or the surface appears smooth and shiny. (Figs 23) 15
- 15(14) Alitrunk, petiole and postpetiole appear smooth and shiny, at most partly very finely superficially striated (Fig. 23). Epinotal spines short. Body colour yellowish red *nitida*
- Alitrunk, petiole and postpetiole with distinct sculpture. If sculpture partly reduced, the surface never appears smooth and shiny, and body colour is dark reddish brown (Figs 25, 27, 29, 32, 34, 38, 39) 16
- 16(15) Large and robust species, with relatively short head ($HW > 1.20$, $AL > 2.0$ mm, $CI < 1.12$). Petiole massive, with very short, thick peduncle, anterior petiolar margin only slightly concave or even almost straight (Fig. 24). Head dorsum with very dense, not coarse longitudinal rugulosity and reticulation, surface between rugulae densely punctured *kozlovi*
- Generally smaller, more slender species with relatively longer head ($HW < 1.15$, $AL < 2.0$ mm, $CI > 1.20$). Petiole with distinct peduncle, anterior petiolar margin sharply concave (Figs 25, 27, 29, 32, 34, 35, 38, 39). Head dorsum with less dense sculpture (Figs 26, 31, 33, 37) 17
- 17(16) Promesonotal dorsum, seen in profile, forming more or less regular arch, mesonotum not impressed transversely; mesonotum gently curves down to the propodeum to form a metanotal groove which is generally shallow but can be quite deep (Figs 25, 27, 29, 32, 34) 18
- Promesonotal dorsum, seen in profile, distinctly impressed transversely, sometimes saddle shape; mesonotum curves down abruptly to propodeum to form distinct, deep and wide metanotal groove (Figs 38, 39) 25
- 18(17) Frontal carinae curved outwards to merge with the rugae which surround antennal sockets (Fig. 26) 19
- Frontal carinae do not curved outwards, continuing to the longitudinal rugae; antennal sockets surround by rugae, which joint frontal carinae (Figs 31, 33) 21
- 19(18) Promesonotal dorsum has reticulate sculpture combined with irregular transversal rugulosity; sides of alitrunk and propodeal dorsum with

- reduced irregular longitudinal rugulosity or even striation. Body dark reddish brown. Propodeal spines short, wide at the base but sharp. Petiolar node with narrowly rounded dorsum (Fig. 25) *wittmeri*
- Whole alitrunk with well developed longitudinal rugosity. Body colour distinctly lighter, from reddish yellow to yellowish red. Propodeal spines usually long and sharp (spine length in *M. smythiesii* quite variable), but not wide at the base. Petiolar node with flattened or convex, broadly rounded dorsum (Figs 27, 29) 20
- 20(19) Petiolar node dorsum distinctly convex, broadly rounded, from above with short, coarse sinuous irregular rugae; postpetiolar node with concentric rugae; both petiole and postpetiole without punctures, surface between rugae smooth and shiny (Figs 27, 28) *fortior*
- Petiolar node dorsum only weakly convex or flat. Petiolar and postpetiolar nodes from above with fine striation and punctures, appear sub-mat (Figs 29, 30) *smythiesii*
- 21(18) Petiolar and postpetiolar nodes densely punctured, without coarse sinuous rugae, only sometimes with short longitudinal rugulae or striation (Figs 32, 34) 22
- Petiolar node with coarse short sinuous rugae, postpetiolar node with coarse concentric rugae (Fig. 35) 24
- 22(21) Head dorsum mainly with longitudinal rugae, reticulate sculpture present only on the occiput and lateral parts of head dorsum above the eyes (Fig. 31). Sides of pronotum mainly with longitudinal rugosity (Fig. 32) . *rugosa*
- Only frons with longitudinal rugae, other parts of head dorsum with reticulate sculpture (Fig. 33). Sides of pronotum with sinuous rugae and reticulation (Fig. 34) 23
- 23(22) Mandibles with 7–9 teeth. Propodeal spines moderately long and straight (ESLI 0.40–0.76, mean 0.62) (Fig. 34) *aimonissabaudiae*
- Mandibles with 10–13 teeth. Propodeal spines somewhat longer (ESLI 0.65–0.81, mean 0.71) *hecate*
- 24(21) Surface of head and alitrunk between rugae without punctures or only with very fine superficial ones, appearing smooth and shiny *rupestris*
- Surface of head and alitrunk between rugae densely punctured, appearing dull *foreliana*
- 25(17) Head dorsum very densely longitudinally rugulose, between frontal carinae level with the eyes there are > 15 rugae; surface between rugae densely punctured, appears dull (Fig. 36) *wardi*
- Head dorsum more coarsely and not so densely longitudinally rugulose, between frontal carinae level with the eyes there are < 13 rugae; surface between rugae smooth and shiny or very finely superficially punctured, not dull (Fig. 37) 26
- 26(25) Sculpture of body relatively coarser; petiole and postpetiole with coarse longitudinally- concentric rugae (Fig. 38). Surface between rugae on whole body smooth and shiny *rhytida*

- Sculpture of body not coarse; petiole and postpetiole densely punctured, without rugae, at most with fine short striation (Fig. 39) 27
- 27(26) Body colour from ochreous yellow to yellowish red. Sides of head with extremely short depressed pubescence, which is visible under magnification $> \times 70$ *cachmiriensis*
- Body colour dark brown to black. Sides of head with much longer decumbent to sub-decumbent pilosity, which is visible under magnification $< \times 30$ *ordinaria*

Discussion

In his general catalogue of ants, BOLTON (1995) lists more than 110 species and infra-specific forms of *Myrmica* recognised from among the Palaearctic ant fauna. About 20 of these were associated with Tibet and the southern parts of the Tien Shan and about 25 were associated with the mountains of the Himalaya, Hindukush and Karakorum. The present study showed that 15 of the latter are good species that belong to the Himalayan *Myrmica* (fauna of the southwestern slopes), while 7 are synonyms. However, RADCHENKO & ELMES (1998, 1999a) added a further 15 new Himalayan species so that the southwestern slopes of the Himalaya and associated mountains appear to be quite rich in *Myrmica*, probably comprising 25–30% of the “good” Palaearctic species. Of the 30 Himalayan species (probably 29 if the dubious record for *M. tibetana* is excluded), 27 appear to be endemic. The Himalayan mountains form a real barrier keeping the *Myrmica* of the southwestern slopes quite distinct from the northern fauna of Tibet, China and Middle Asia (Turkmenistan, Uzbekistan, Kirgizstan and Tadzhikistan). Only *M. kozlovi*, has managed to directly cross from east to west (rather than circumvent via the north), probably because it can live at the highest altitudes reported for any *Myrmica* species (4800m).

We clustered the 30 Himalayan *Myrmica* together by extending the concept of species groups (Fig. 40) that were proposed by RADCHENKO (1994a). These groups themselves group together into three major clusters, based upon the shape of the antennal scapes of males and females. The most primitive characters are believed to be short male scapes and long gently curved queen scapes (RADCHENKO 1994a). Five groups have both these “primitive” characters, four of which contain Himalayan species and the fifth (*luteola*-group) is East Asian. A cluster of four groups have males with long scapes and females with curved scapes, all except the *rubra*-group, are associated only with the Himalaya, East and Middle Asia. No Himalayan species belong to the cluster of three groups that have males with more or less short scapes and females with antennal scapes that are sharply angled at the bend. Thus not only are most Himalayan species endemic, they also appear to us, to be morphologically “primitive” (based at least, on scape characteristics). In order to explain this statement, we outline our views on the possible evolution of the genus (a fuller treatment will be made when our ongoing revisions of the Chinese and Korean, and Turkish, Persian and Caucasian *Myrmica* fauna are completed).

Myrmica belongs to the tribe Myrmicini, which is believed by most authors to be the most “primitive” among the subfamily Myrmicinae. The plesiomorphic state of various morphological features is usually cited as evidence in support of this view, e.g. 6-jointed maxillary and 4-jointed labial palps, a primitive structure of the mesosoma with non-fused sutures etc., and the presence of pectinate spurs on the mid and hind tibia. Species of *Manica* JURINE, 1807 appear to possess more “primitive” features than any other Myrmicini, e.g. a full complement of mesosomal sutures with some large specimens having a rudimentary scutellum, so that one is tempted to assume that *Myrmica* derived from a *Manica* ancestor. However, there is no palaeontological evidence for this. The oldest fossil Myrmicini, dating from the late Eocene (MAYR 1868; WHEELER 1915), are assigned to *Myrmica* and *Nothomyrmica* WHEELER, 1915; these closely related genera differ only by the absence of pectinate spurs in *Nothomyrmica*, a character now known to be absent in some species of *Myrmica*. Furthermore, the present distributions suggest different centres of origin for *Manica* (North America) and *Myrmica* (Eurasia).

Ritae-group species most resemble the fossil *Myrmica* and we consider them to be among the most primitive of the extant *Myrmica*. Also, males of *ritae*-group have short scapes, this feature is believed to be primitive and plesiomorphic to all ant species. However WEBER (1950) suggested that *M. ritae* and related species, have habits and characters which are very similar to some tropical species of *Aphaenogaster* MAYR, 1853 (tribe Pheidolini). For example, the general morphology and geographic location of *M. gigantea* led COLLINGWOOD (1962) to place this species to *Aphaenogaster* when he first described it. Any resemblances are more probably due to a convergence like for example, that between *Messor* FOREL, 1890 (Pheidolini) and *Pogonomyrmex* MAYR, 1868 (Myrmicini) or *Cataglyphis* FÖRSTER, 1850 (Formicini) and *Myrmecocystus* WESMAEL, 1838 (Lasiini). We suggest that species resembling modern *Manica*, *M. ritae* and *Myrmica mirabilis* ELMES & RADCHENKO (1998) first arose from a common ancestor during the early Eocene.

The ancestral species resembling the *ritae*-group became widespread in parts of Eurasia under a climate similar to that of modern subtropical regions. Later they became rarer as suggested by their scarcity in Baltic Amber compared with other ground- and litter-foraging species. They are totally absent in Oligocene and Miocene deposits of Eurasia, despite the presence of quite a rich ant fauna (THÉOBALD 1937; DLUSSKY 1981; ZHANG 1989). We suggest that during this period the ancestral *Myrmica* of Eurasia retreated to the south, predominantly to what is now South-East Asia. These subsequently started a geographical radiation and speciation during the Pliocene, probably as a consequence of climatic cooling and the formation of more recent forest zones (unfortunately there are no data on ant fauna of Eurasia at this time). Thus while modern *Myrmica* might have evolved entirely from *M. ritae* like ancestors, there more probably were several “primitive” ancestral groups. For example one ancestor might have been similar to *Myrmica mirabilis* of central Taiwan; this is an unusually large species belonging to the *luteola*-group and having some quite atypical characters that are more reminiscent of *Manica* or *Pogonomyrmex* (ELMES & RADCHENKO 1998). During the Pleistocene, periods of isolation probably led to the differences between species

groups that are associated with different geographic regions, and left the “more primitive” *ritae*-group and species such as *M. mirabilis*, confined to the mountain tops of subtropical South-East Asia. The ant fauna of these mountains are relatively poorly known and we predict that the phylogeny of the genus *Myrmica* might become more tractable as the biodiversity of these regions becomes better catalogued.

Assuming a *ritae*-like ancestor, we suggest that two major divergences occurred during the process of adaptive radiation (Fig. 40). These were the evolution of sharply angled antennal scapes in the queen and longer antennal scapes among males. We offer no opinion as to the relative timing of these but suggest that angled queen scapes are probably a functional adaptation to foraging on the soil surface and more cryptically, under leaves and moss. The acutely angled bend appears to enable the ants to retract the antenna more closely against the sides of their heads and undoubtedly, the width of the frons and shape and size of the antennal lobes and other thickenings will be shown to have a functional relationship with the musculature which controls the movement of the antennae. Species having angled scapes are absent from the Himalayan fauna. A functional explanation for the evolution of longer male scapes is harder to postulate, possibly it is related to swarming behaviour and the distance and height males fly to find queens.

The Himalayan *Myrmica* fauna contains half (5) the known species belonging to the *ritae*-group and many others, which have “primitive” characters similar to those of the *ritae*-group. The females of all 30 species share a common “primitive” feature of antennal scapes that are only slightly curved at the base, not angular with no trace of a lobe (see above). Moreover, the majority of species in which males are known, have males with the more “primitive” short antennal scapes. The major barrier and comparative isolation created by the high Himalaya appears to have resulted in a mixture of relict forms and species derived directly from them, many of which are distinctive from all other *Myrmica* species (both Palaearctic and Nearctic). Distinctive characters include coarse transverse rugosity of the alitrunk dorsum, punctato-striated first abdominal tergite (known previously in two Nearctic species – *M. striolagaster* COLE, 1953 and *M. punctiventris* ROGER, 1863), smooth and shiny surfaces of the alitrunk, very long petiole and propodeal spines and multidentate mandibles with more than 10 denticles. Lack of multidentate mandibles are now used by taxonomists as an important character for the discrimination of *Myrmica* from genus *Manica*, a species which is believed to be close to the ancestral *Myrmica* species (see above).

Apart from *M. kozlovi* which appears to have crossed the Himalaya from east to west (discussed above) the other species that appear to have more modern or derived characters (*tibetana*-group and *smythiesii*-complex), have closely related forms in Middle Asia and Tibet. All known males from the *smythiesii*-complex species have long scapes but the *tibetana*-group males have short scapes which we think places them closer to the more “primitive” *rugosa*-group (Fig. 40). However, *M. tenuispina* workers also have features shared with the *scabrinodis*-group (curved frontal lobes and antennal sockets not surround by the rugae). These “more derived” species are associated with East Afghanistan and North-West Himalaya and we guess that they constitute relatively “young elements” in the Himalayan myrmecofauna, that have migrated from the

northeastern mountain regions via the Hindukush and Karakorum. Finally, we stress that the southwestern Himalaya, even at very high altitudes, supports no typical boreal *Myrmica* species similar to *M. sulcinodis* NYLANDER, 1846, *M. lobicornis*, *M. ruginodis* etc., which are found in Western China.

We conclude that the conspicuous and unusual Himalayan *Myrmica* comprise one of the oldest and most diverse faunas of the genus. Comparative ecological and behavioural studies of species such as *M. indica*, *M. pachei*, *M. inezae* and *M. rugosa* would surely be well rewarded in terms of understanding the bewildering range of biologies that are well documented in European species (e.g. ELMES 1991). For example, given the diversity of Himalayan species now known, there is a surprising absence of social parasites (only *M. erepatrix* has been described so far), it is interesting to speculate whether this reflects a lack of detailed collecting effort or whether social parasites are relatively uncommon. If the latter is true, then it may be that something in the biology of the more “primitive” species renders their colonies less prone to parasitic invasion compared to the “more derived” European species.

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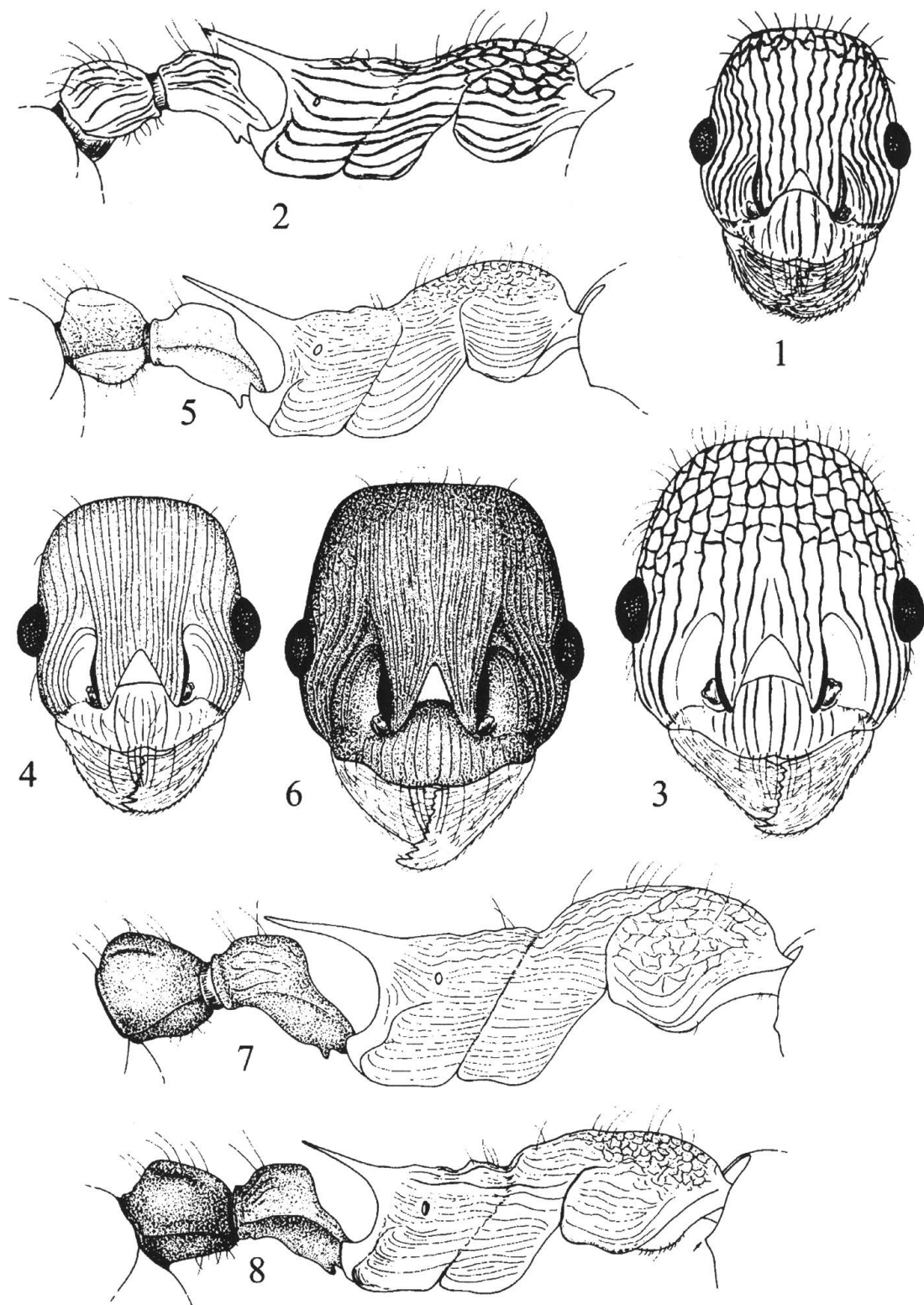
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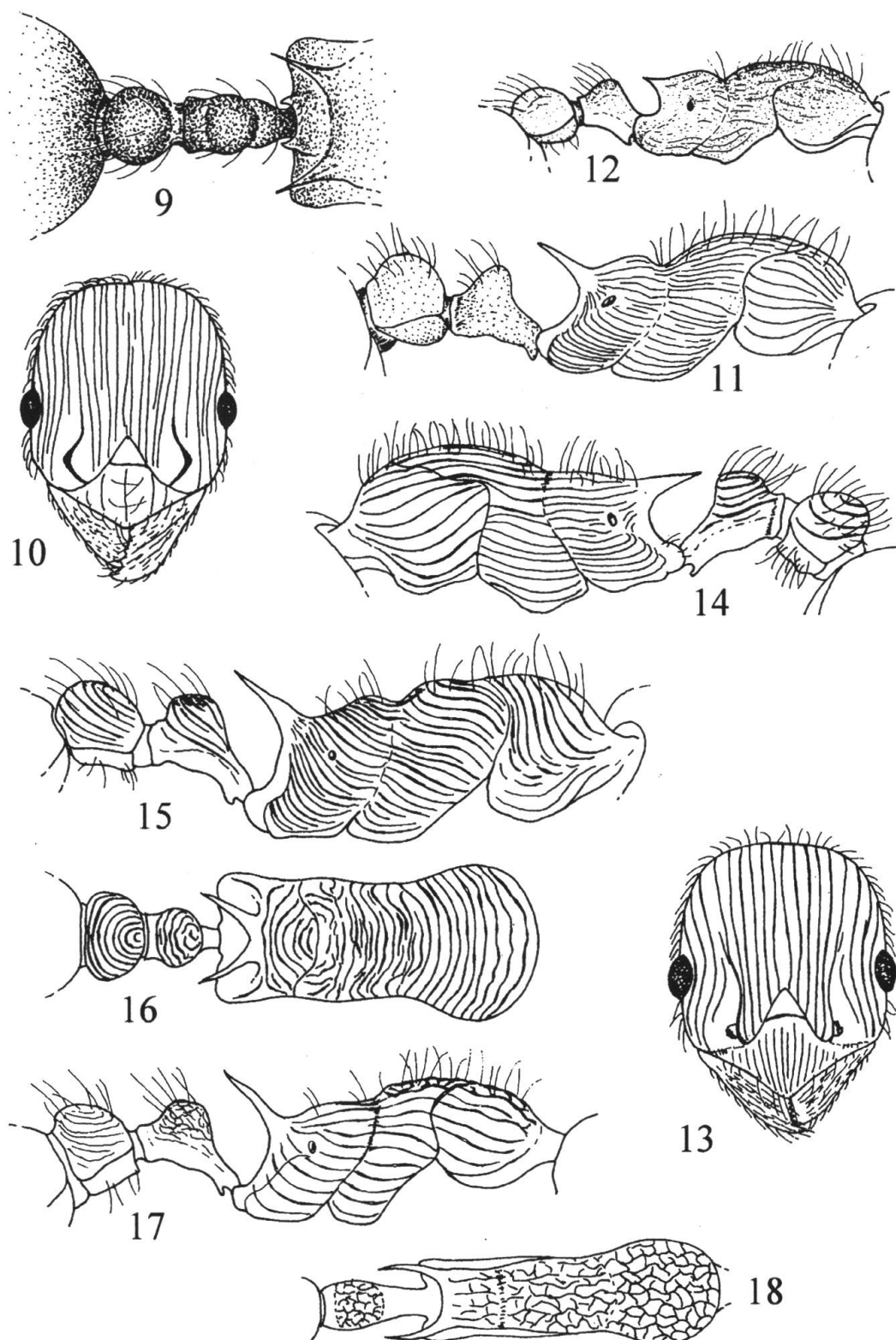
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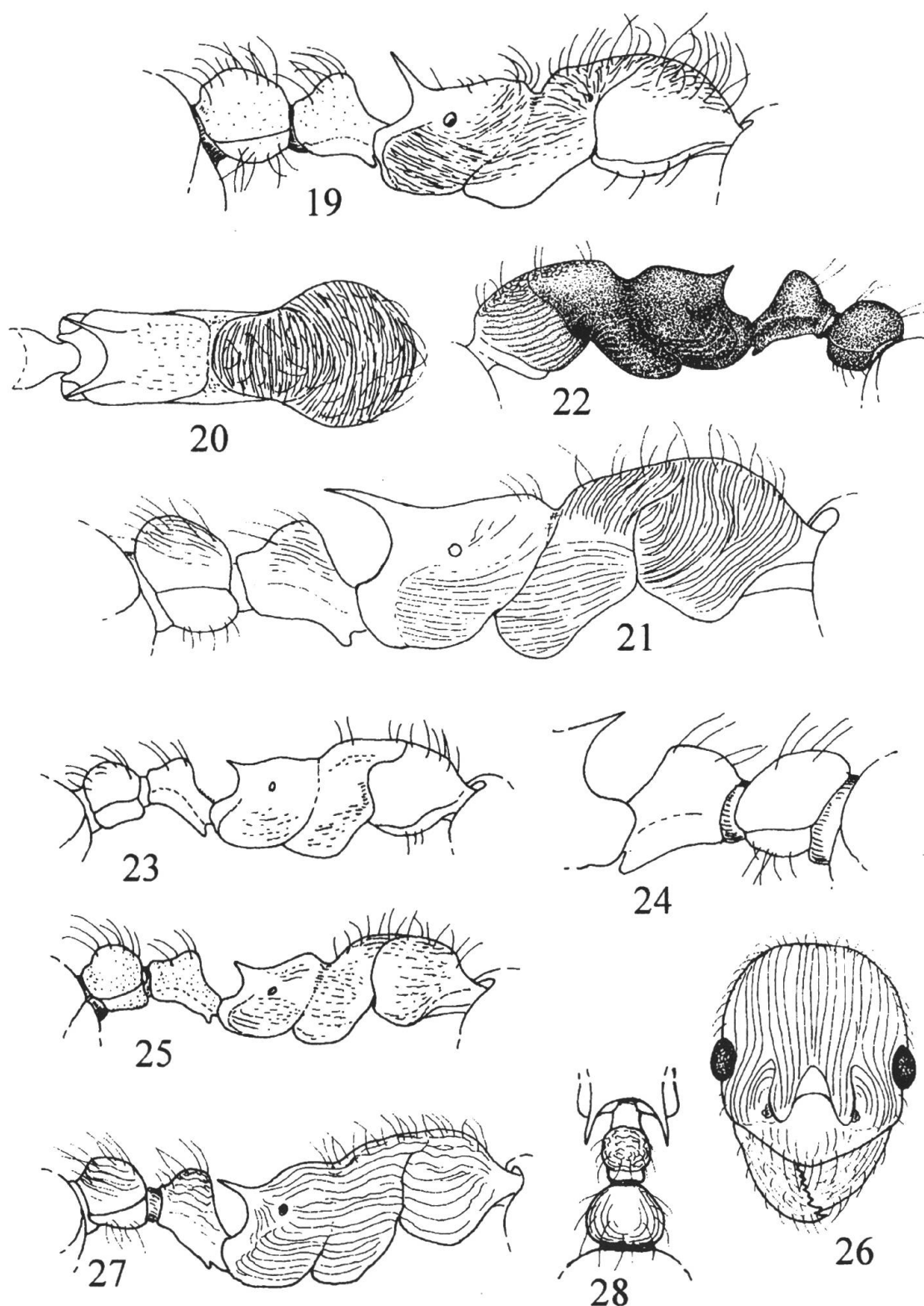
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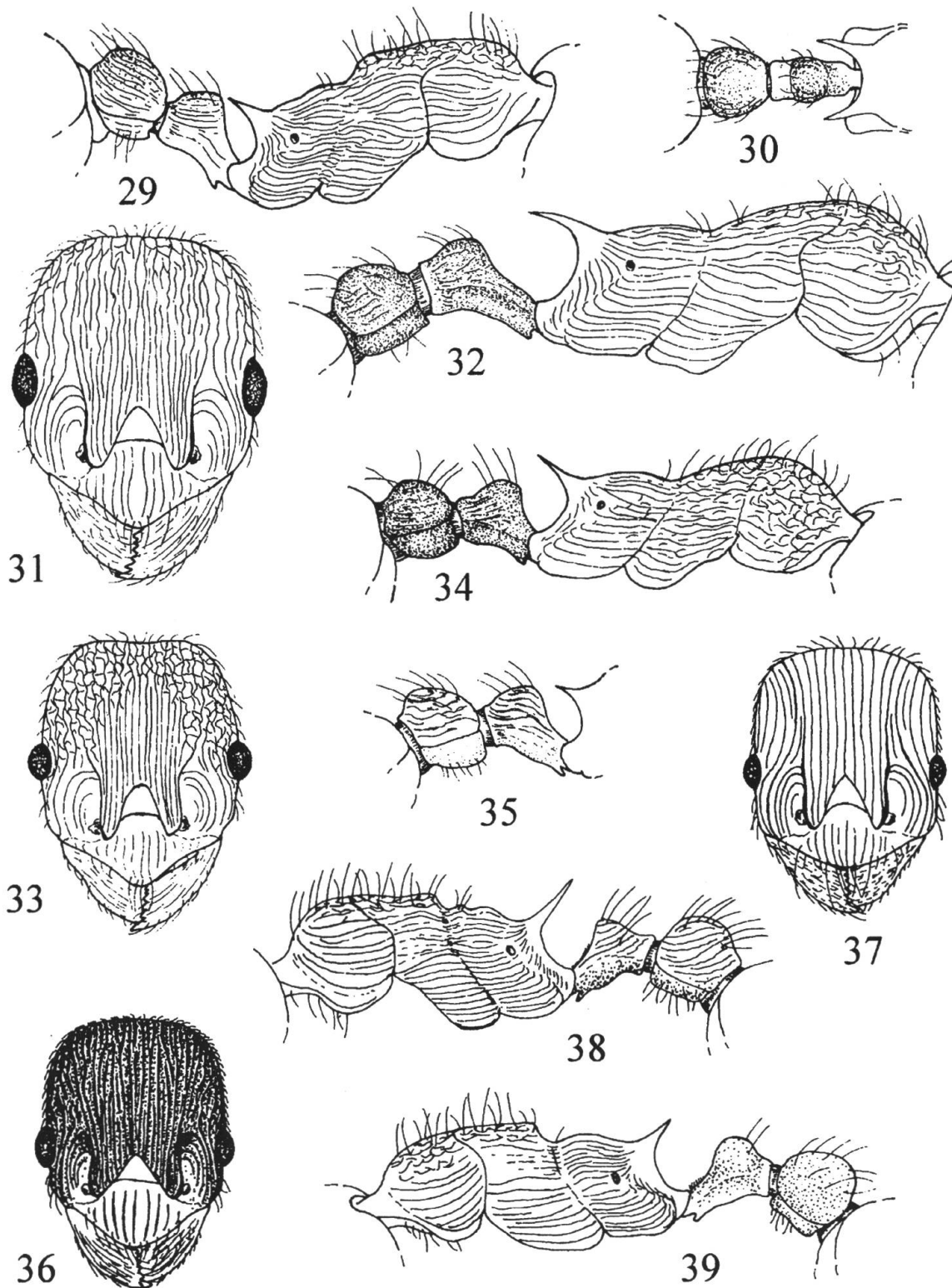
Figs 1–8: Details of structure of *M. indica* (1, 2, lectotype worker), *M. urbanii* (3), *M. collingwoodi* (4, 5), *M. boltoni* (6, 7), *M. martensi* (8) (all holotypes workers): 1, 3, 4, 6 – head, frontal view; 2, 5, 7, 8 – alitrunk and waist in profile.



Figs 9–18: Details of structure of *M. brancuccii* (9, holotype worker), *M. tenuispina* (10, 11, worker), *M. tibetana* (12, lectotype worker), *M. vittata* (13, 14), *M. inezae* (15, 16), *M. rigatoi* (17, 18) (all holotypes workers): 9 – base of first gastral tergite, waist and propodeal spines from above; 10, 13 – head, frontal view; 11, 12, 14, 15, 17 – alitrunk and waist in profile; 16, 18 – alitrunk from above.



Figs 19–28: Details of structure of *M. villosa* (19, 20, holotype worker), *M. pachei* (21, worker), *M. williamsi* (22, holotype worker), *M. nitida* (23, holotype worker), *M. kozlovi* (24, paralectotype worker), *M. wittmeri* (25, holotype worker), *M. fortior* (26–28, lectotype worker): 19, 21–23, 25, 27 – alitrunk and waist in profile; 20 – alitrunk from above; 24 – waist in profile; 26 – head, frontal view; 28 – waist and propodeal spines from above.



Figs 29–39: Details of structure of *M. smythiesii* (29, 30), *M. rugosa* (31, 32), *M. aimonissabaudiae* (33, 34), *M. rupestris* (35) (all lectotypes workers), *M. wardi* (36), *M. rhytida* (37, 38), *M. ordinaria* (39) (all holotypes workers): 29, 32, 34, 38, 39 – alitrunk and waist in profile; 30 – waist and propodeal spines from above; 31, 33, 36, 37 – head, frontal view; 35 – waist in profile.

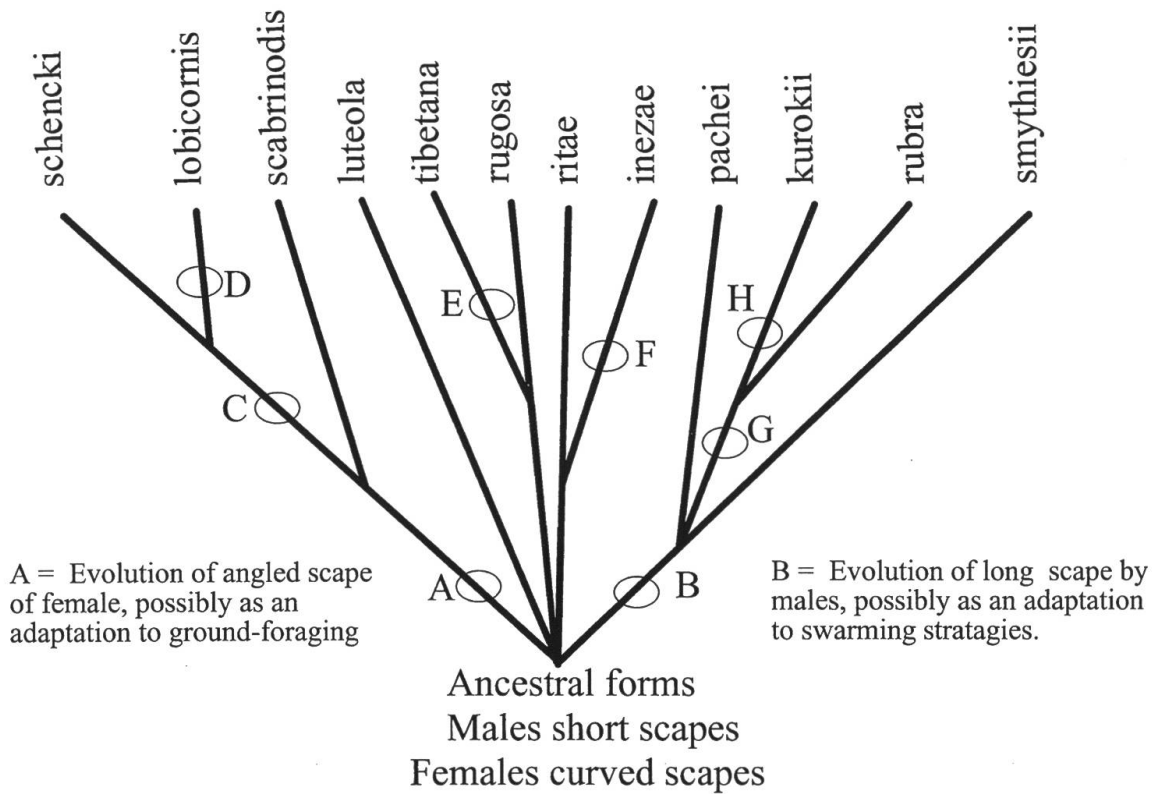


Fig. 40: The twelve species groups of *Myrmica* recognised in this revision. They are clustered in a way that loosely reflects their possible evolutionary relationship. Clusters discriminated by A & B represent major divergences from the ancestral forms based on the scape shapes of the females and males. Secondary clusters are discriminated by C = vertical flange, tooth or thickening on the bend of the female scape; D = increased length of male scape (but not as extended as B); E = absence of rugae surrounding antennal socket; F = shortened peduncle of petiole (but still longer than other groups); G = even longer male scapes; H = thickening and shortening of peduncle of petiole (shorter than all other groups).