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Biogeography and Ecology of *Myrmica* species (Formicidae: Myrmicinae) in Himalayan regions

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Abstract
Updated information on distribution and ecology of Himalayan *Myrmica* species is provided. Altitudinal ranges for most of the *Myrmica* species in Himalaya are redefined.

Introduction

The ant genus *Myrmica* Latreille, 1804 comprises of 164 valid species (including five fossil species from the European late Eocene ambers) in the Old World (Radchenko & Elmes, 2010; Bharti & Sharma, 2011a, b, c, 2013; Bharti, 2012a, b; Bharti et al., 2016a, b; Chen et al., 2016). These species are widely distributed in the Palearctic and Southeast Asian tropical and subtropical regions. The *Myrmica* fauna of the Central Asian mountains, an area covering Hindu Kush, Karakorum, Southwestern slope of Himalaya (Afghanistan, Pakistan, India, Nepal and Bhutan), corresponds to 43 known species, 41 of which are, up to date, endemic to this region (Radchenko & Elmes, 1998, 1999, 2001, 2003a, b, 2009, 2010; Radchenko et al., 2007; Bharti, 2008, 2012a, b, 2013; Elmes & Radchenko, 2009; Bharti & Sharma, 2011a, b, c, 2013; Bharti et al., 2016a, b). The Himalayan *Myrmica* species are cold-hardy and survive well in the harsh high altitude conditions like paucity of resources, negligible nesting sites, short summers and long winters with below zero temperatures. Due to their adaptability, sheer dominance and exploitation of meagre resources, these species are the keystone players in the high altitude ecosystems of Himalaya (Bharti, 2013). However, not much is known about the ecology of these species, since most were described based on the already collected material deposited in various museums. Thus, here we provide an updated distribution, notes on ecological aspects and redefined altitudinal ranges for most of the *Myrmica* species from Himalaya.

Materials and Methods

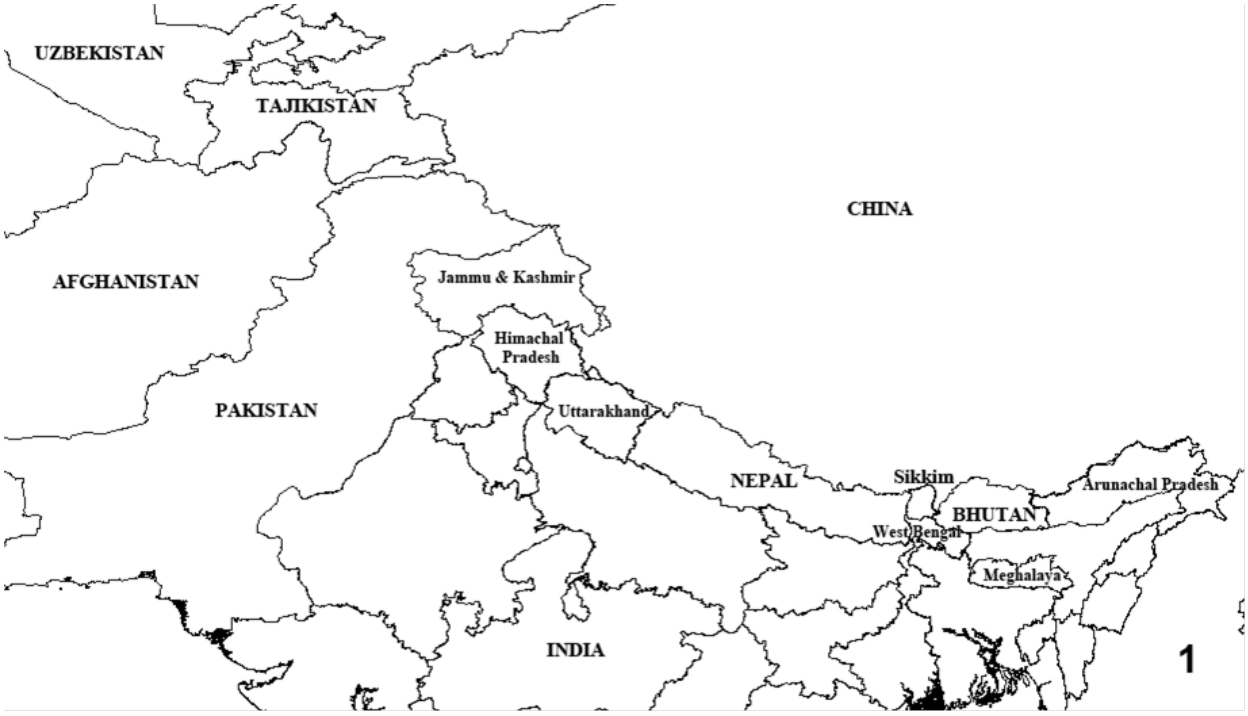
The updated information on distribution, altitudinal ranges and ecology is primarily based on the material recently collected by the first author and his team from Himalaya, with input of already existing information in literature as well. For sake of convenience, the distribution cited from earlier data has been labelled as follows:

(1) Specimens at the PUAC - Punjabi University, Patiala, Ant Collection.

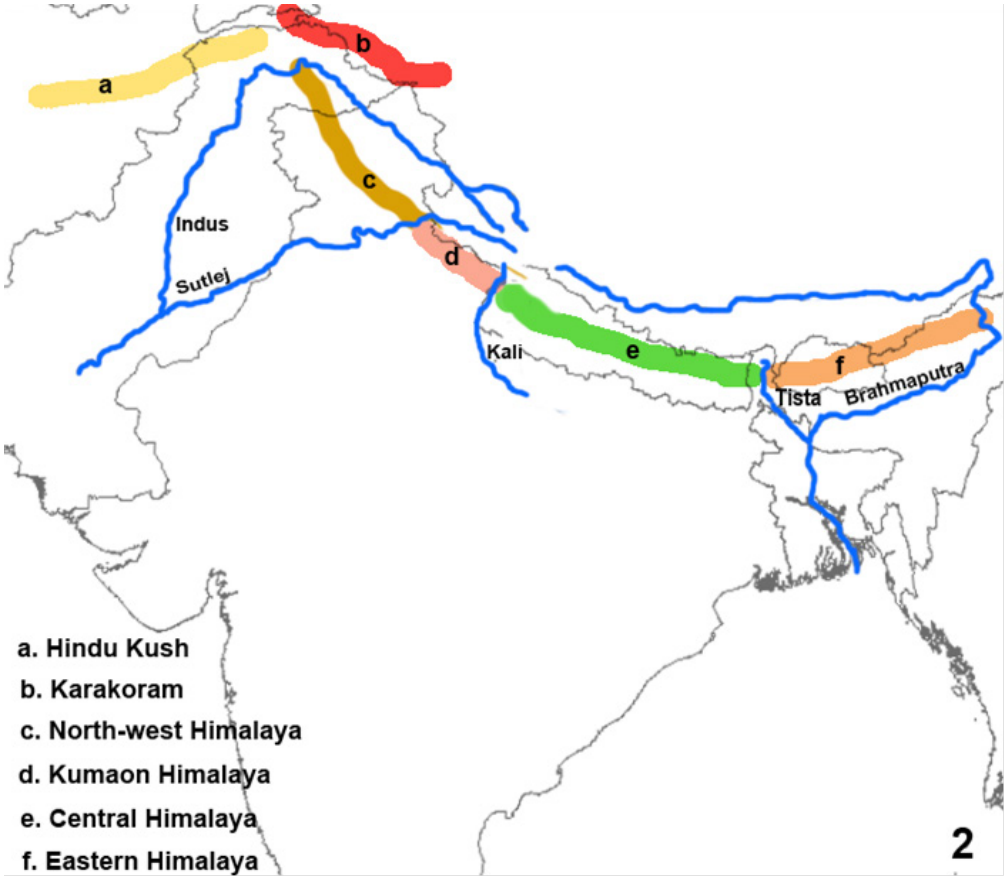
(2) Radchenko and Elmes, 2001.
(3) Radchenko and Elmes, 2010.

Regarding the usage of term gyne and queen in the manuscript: "gyne" means alate young female, "queen" means dealate, most probably fertile, female (Wilson, 1971; Hölldobler & Wilson, 1990).

Maps showing the known distribution of *Myrmica* species were generated using DIVA-GIS software version 7.5.0.0.



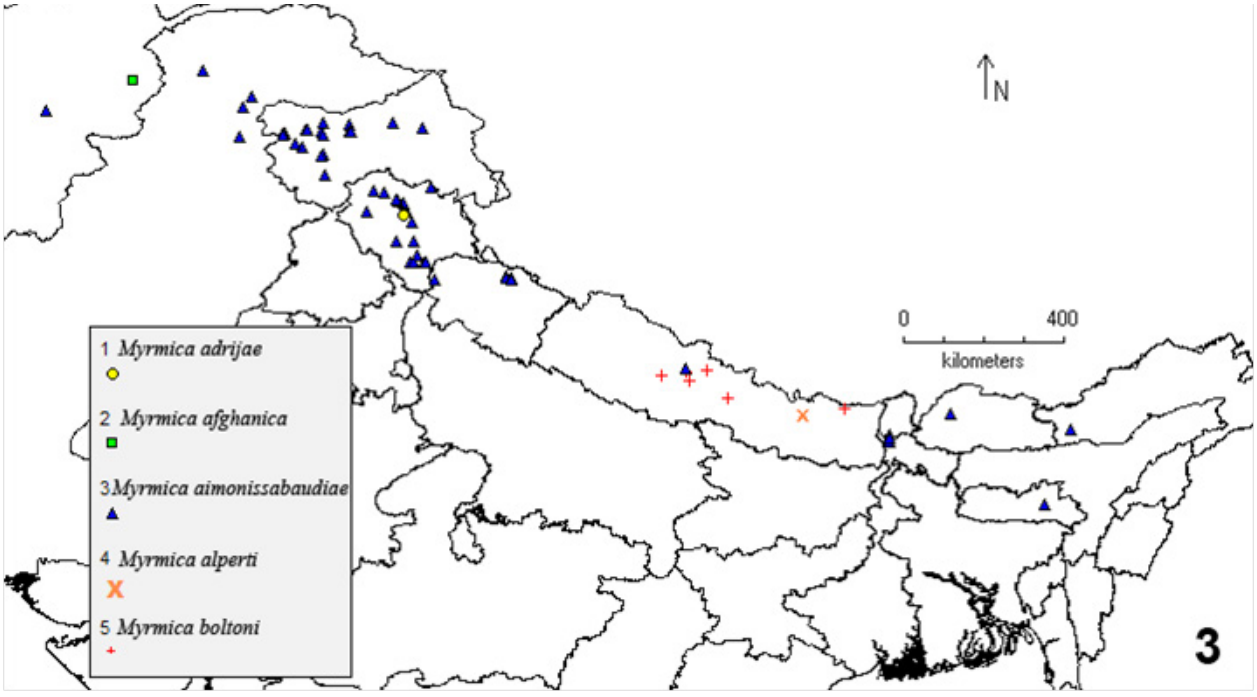
Map 1. Geographic position of states of India (lowercase) and other countries (uppercase) where *Myrmica* species are distributed.



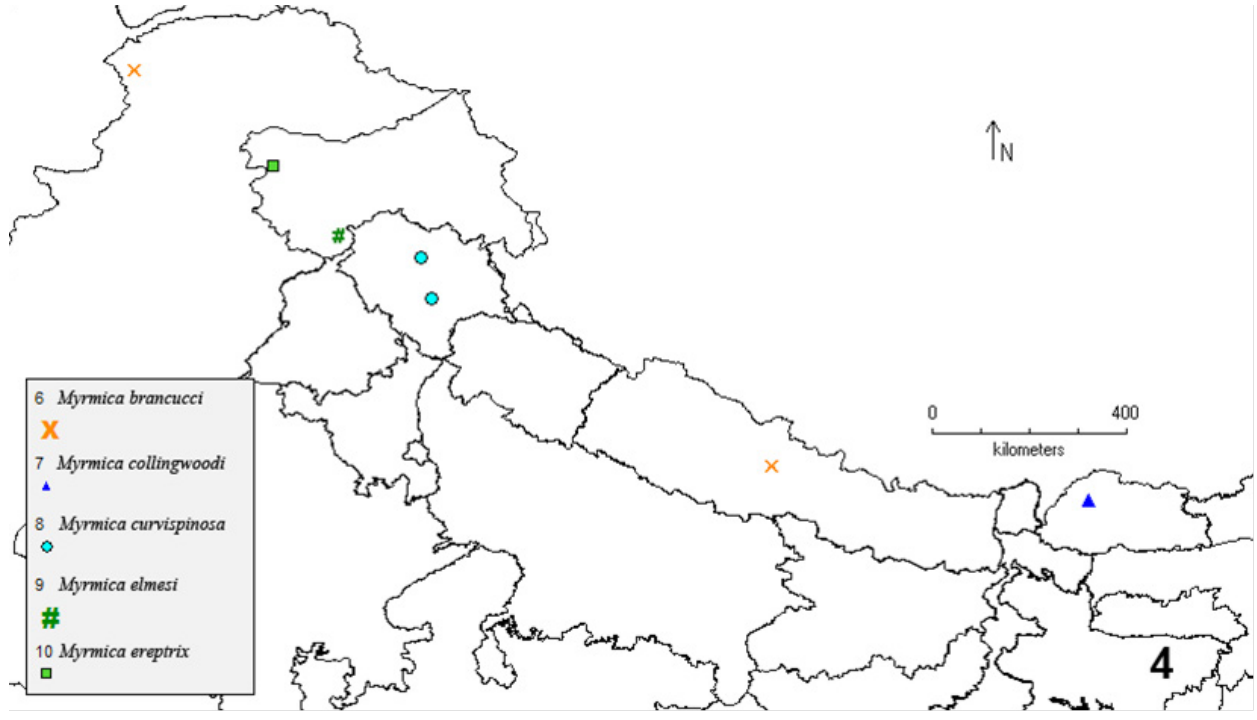
Map 2. Geographic divisions of Indian Himalaya.

Acronyms of depositories of *Myrmica* material analysed for the manuscript:

ASPC: Leilingen, Germany (private collection of Schulz)
BMNH: Natural History Museum, London (collections of Donisthorpe and Bolton, and very rich material from the whole World)
CAC: Leeds Museum UK (collection of Cedric Collingwood)
GEPC: Centre for Ecology and Hydrology, Wallingford, UK (private collection of Elmes)
JMPC: University of Mainz, Germany (private collection of Martens)
MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA (many types plus collections of Wheeler, Finzi and Weber)
MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland (collection of Forel)
MMPC: Instituto di Zoologia, Roma, Italy (private collection of Mei)
MSNG: Museo Civico di Storia Naturale "Giacomo Doria",

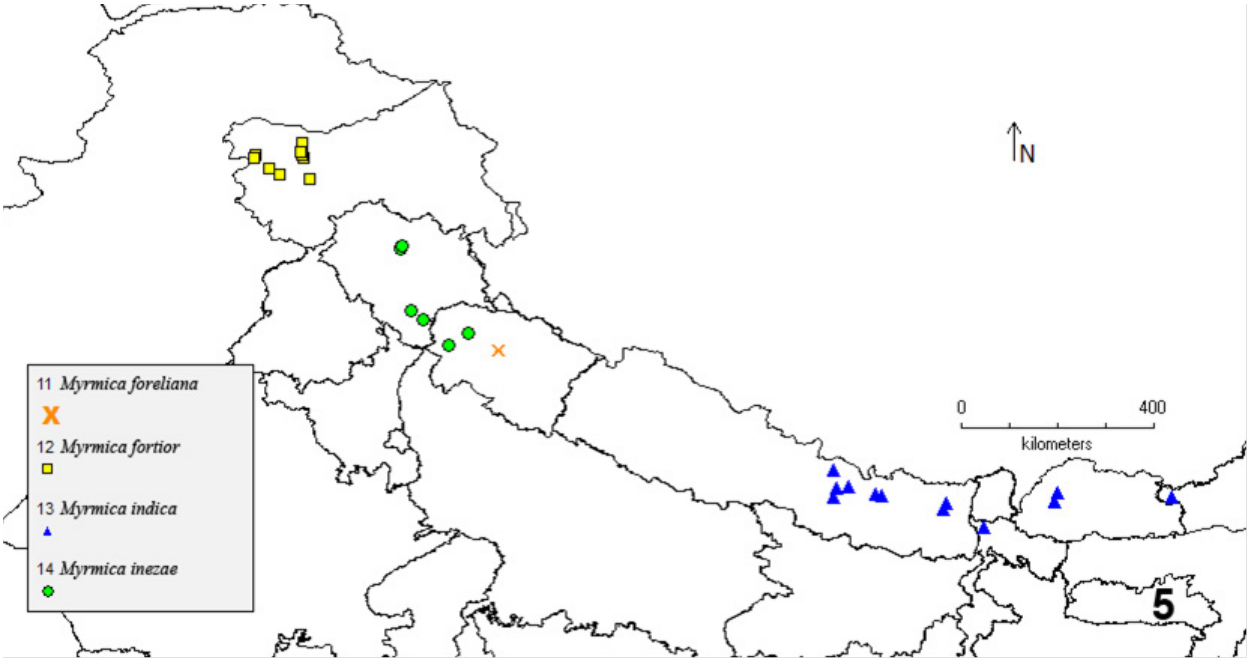


Map 3. Known distribution of *Myrmica adrijae, M. afghanica, M. aimonissabaudiae, M. alperti, M. boltoni.*

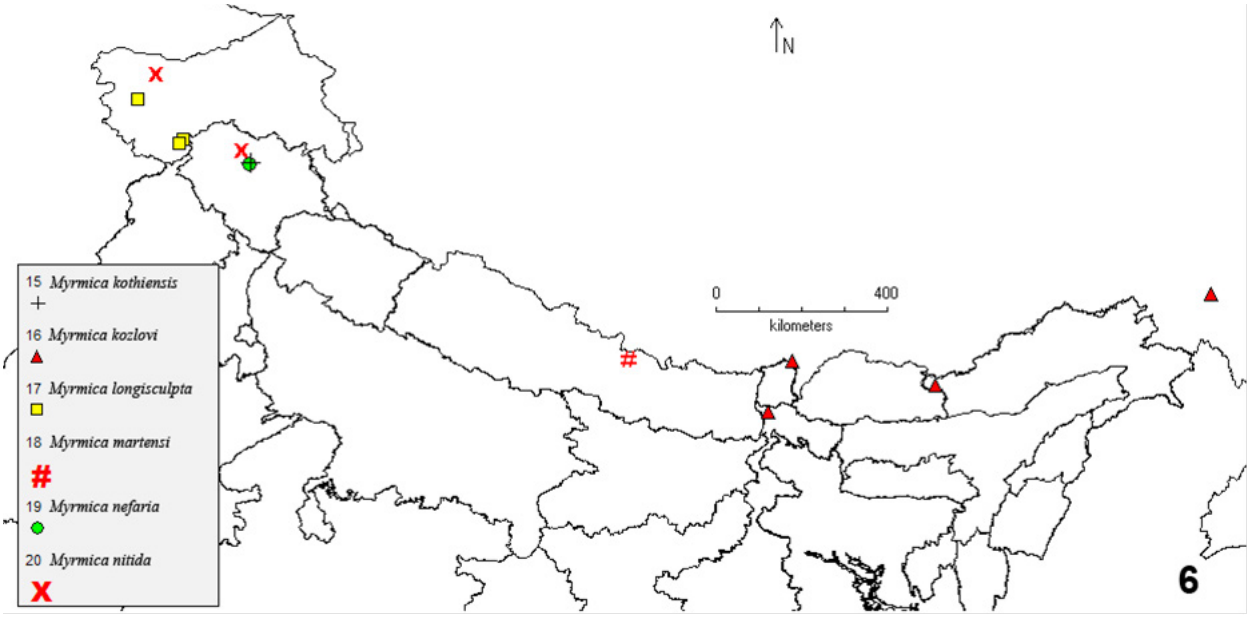


Map 4. Known distribution of *Myrmica brancuccii*, *M. collingwoodi*, *M. curvispinosa, M. elmesi*, *M. ereptrix.*

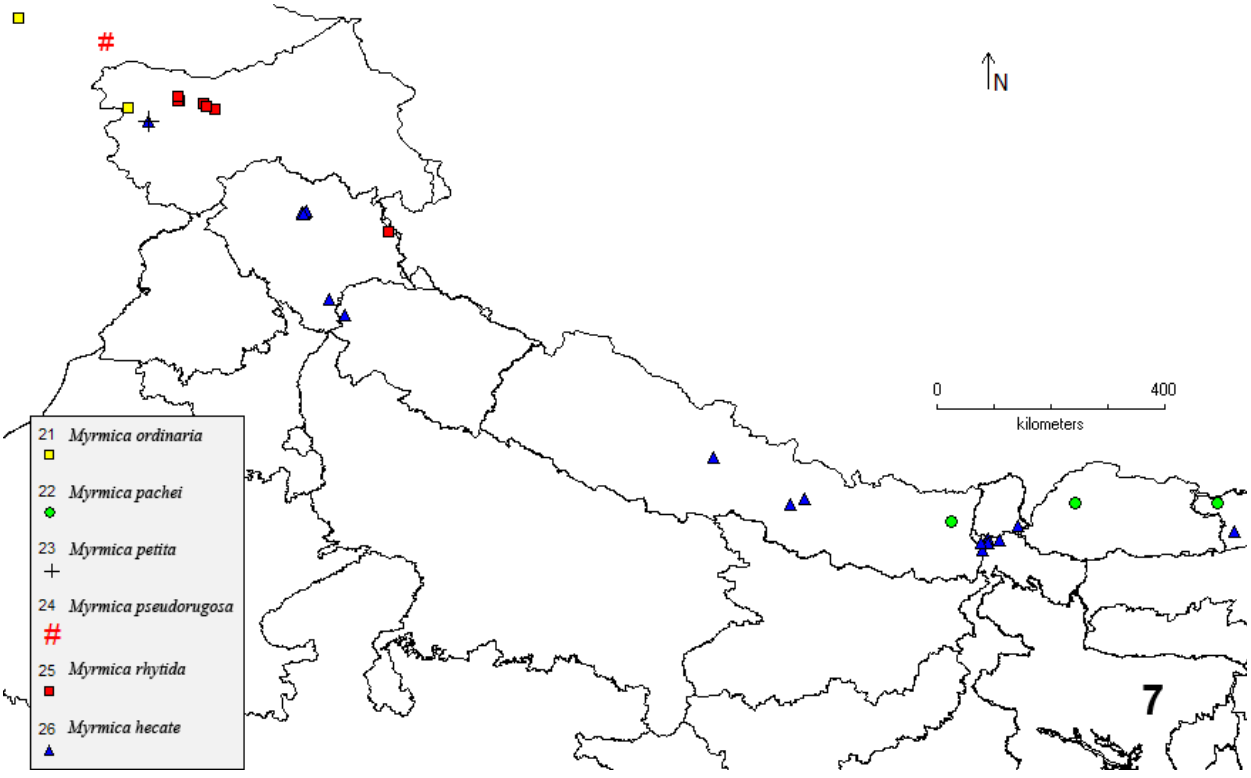
Genoa, Italy (collection of Emery and some type specimens of Ruzsky)
MSNM: Museo Civico di Storia Naturale, Milan, Italy (collections of Rigato and Poldi)
NHMB: Naturhistorisches Museum, Basel, Switzerland (collections of Santschi and partly of Forel)
NHRS: Naturhistoriska Riksmuseet, Stockholm, Sweden
PSWC: University of California, USA (collection of Ward)
PUAC: Punjabi University, Patiala, Ant Collection
SIZK: Schmalhausen Institute of Zoology of the Ukrainian National Academy of Sciences, Kiev, Ukraine (collections of Karawajew and Radchenko)
UMO: Hope Entomological Collections, University Museum, Oxford, England, UK (collections of Rothney, F. Smith, etc.)
ZISP: Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia (part of material of Ruzsky's and Arnoldi's collections)
ZMHB: Museum für Naturkunde der Humboldt Universität, Berlin, Germany (collections of Stitz and partly of Mayr and Viechmeyer)
ZMMU: Zoological Museum of Moscow State University, Moscow, Russia (collections of Arnoldi, Dlussky, and partly of Nasonov and Ruzsky).
ZMUC: Zoological Museum of the University of Copenhagen, Denmark (collection of Meinert)



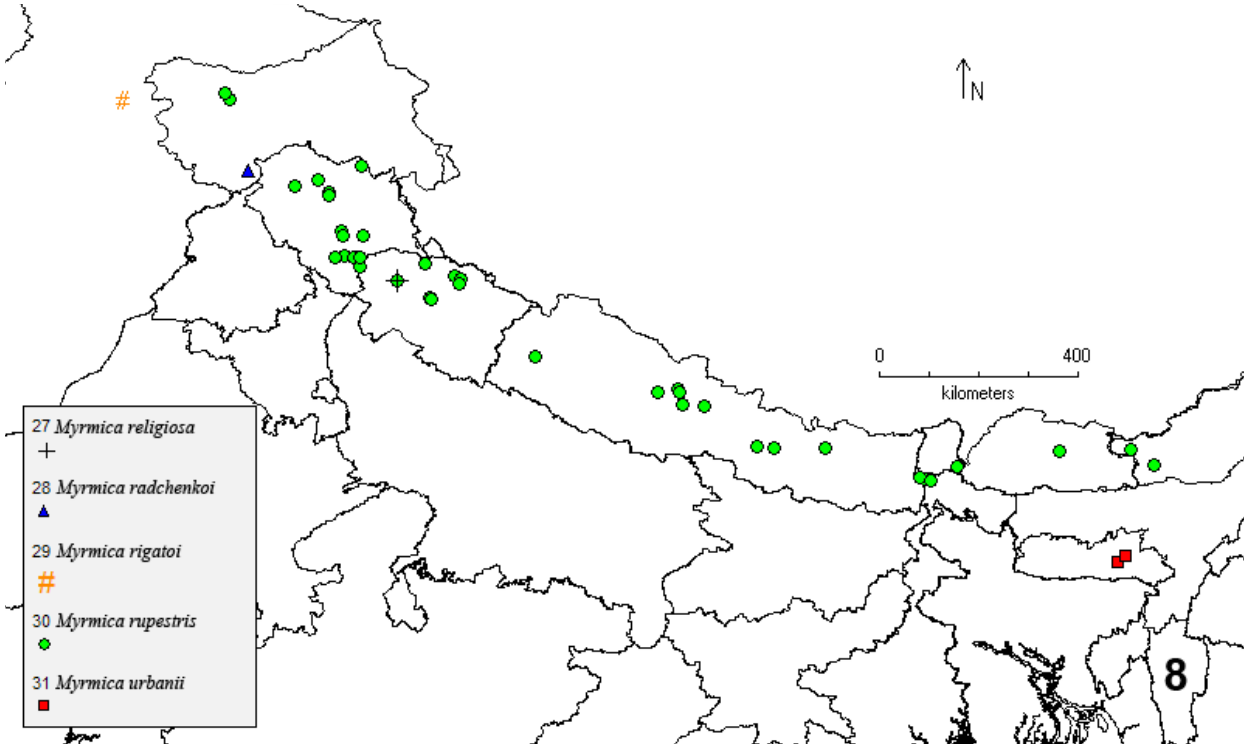
Map 5. Known distribution of *Myrmica foreliana*, *M. fortior*, *M. indica*, *M. inezae*.



Map 6. Known distribution of *Myrmica kothiensis*, *M. kozlovi, M. longisculpta, M. martensi, M. nefaria*, *M. nitida.*



Map 7. Known distribution of *Myrmica ordinaria*, *M. pachei*, *M. petita*, *M. pseudorugosa, M. rhytida, M. hecate.*



Map 8. Known distribution of *Myrmica religiosa*, *M. radchenkoi, M. rigatoi*, *M. rupestris, M. urbanii.*

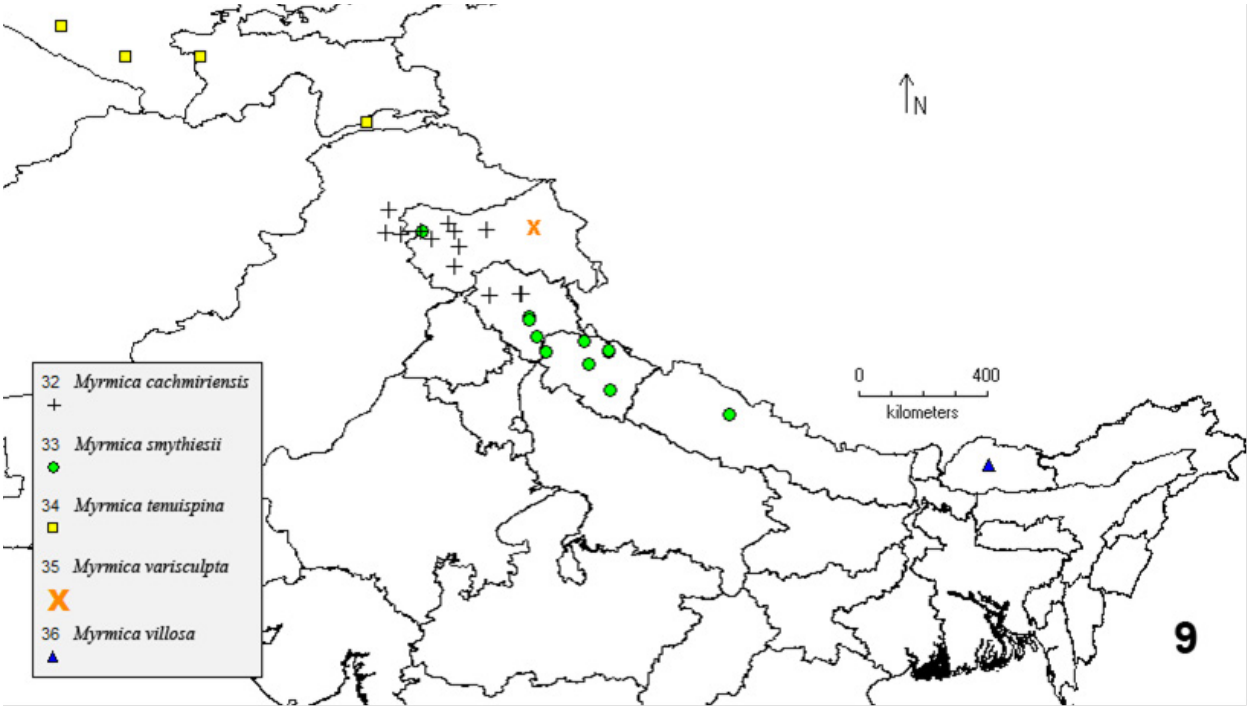
Results

Myrmica adrijae Bharti, 2012

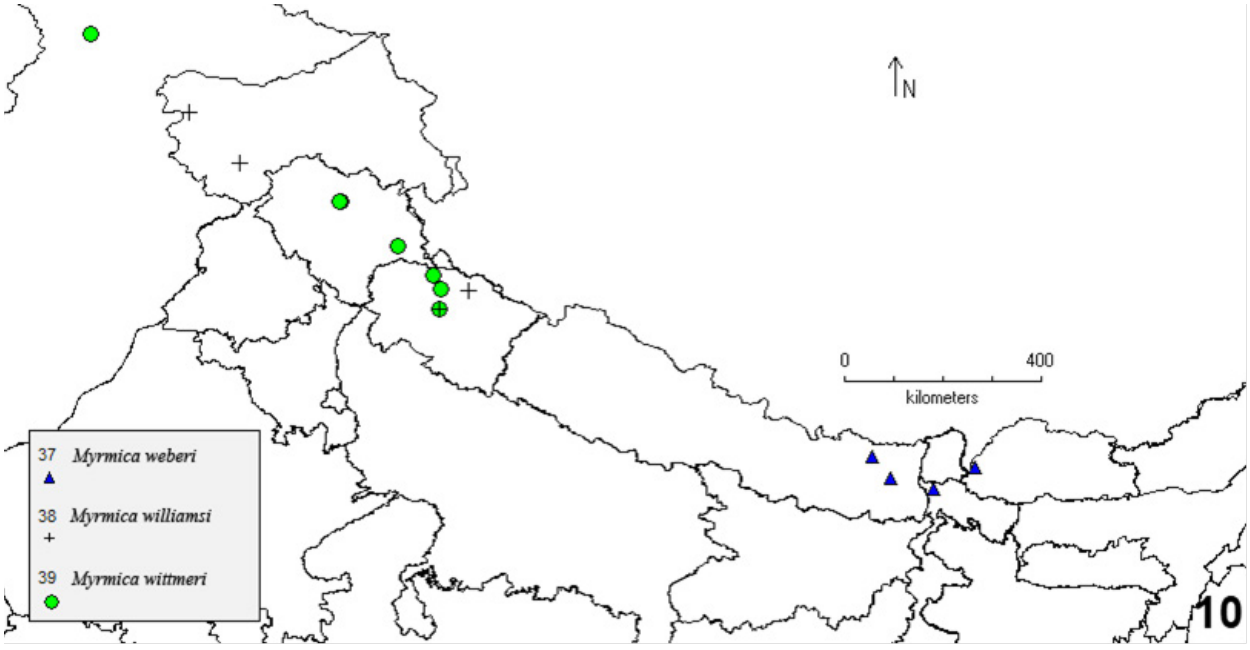
Holotype: worker, "India, Himachal Pradesh, Kothi, 2479 meters above m. s. l., 29.vi.1999" (coll. H. Bharti, code = 193) (PUAC); **Paratypes:** 5 workers, collected from the same nest. GPS coordinates 32.1890°N–77.1170°E (BMNH; PUAC).

Distribution: India: Himachal Pradesh (1).

Ecology: *Myrmica adrijae* was collected from a nest under stone on a mountain slope with a patchy *Cedrus* forest having grass cover. The nest was small with 6 workers. The recorded nest temperature at the site was 20˚C.



Map 9. Known distribution of *Myrmica smythiesii*, *M. cachmiriensis, M. tenuispina*, *M. varisculpta*, *M. villosa.*



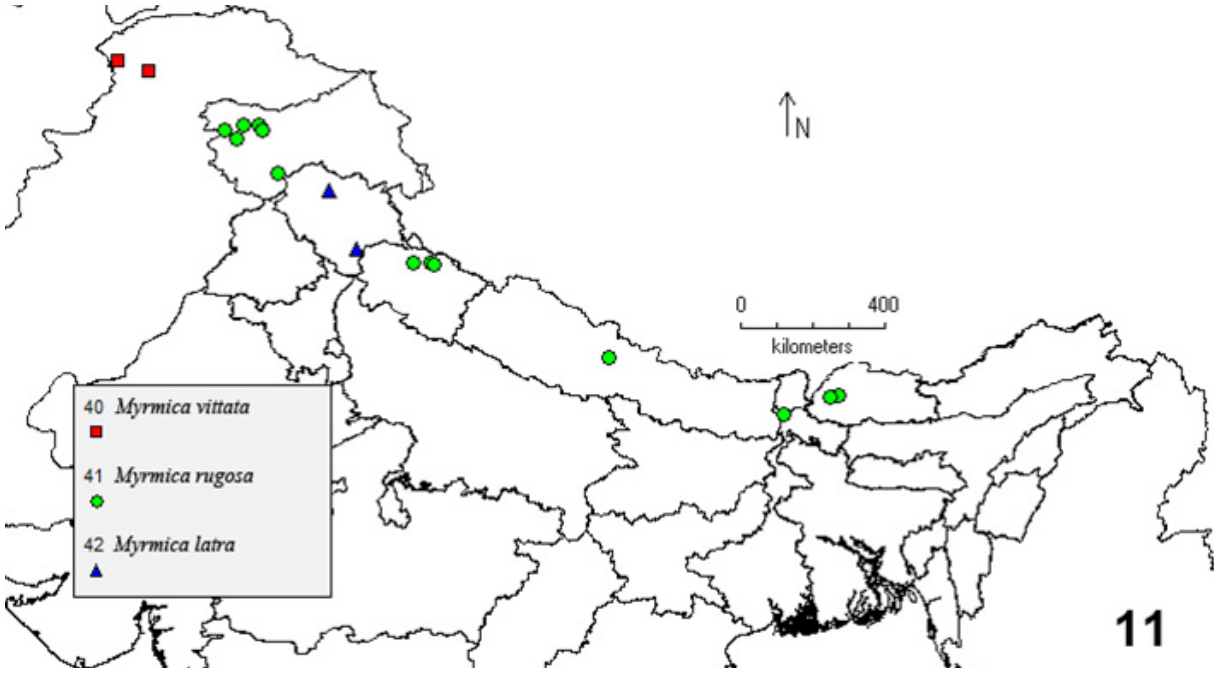
Map 10. Known distribution of *Myrmica weberi*, *M. williamsi, M. wittmeri*.

Myrmica afghanica Radchenko et Elmes, 2003
Holotype: worker, "Afghanistan, Pashki Nuristan, 6.vi.1948, leg. K. Paludan" (ZMUC);
Paratypes: 2 workers, 1 gyne (specimen without postpetiole and gaster), "Afghanistan, Pashki Nuristan, 6.vi.1948, leg. K. Paludan" (ZMUC).
Distribution: Northeastern Afghanistan (3).
Ecology: Unknown.

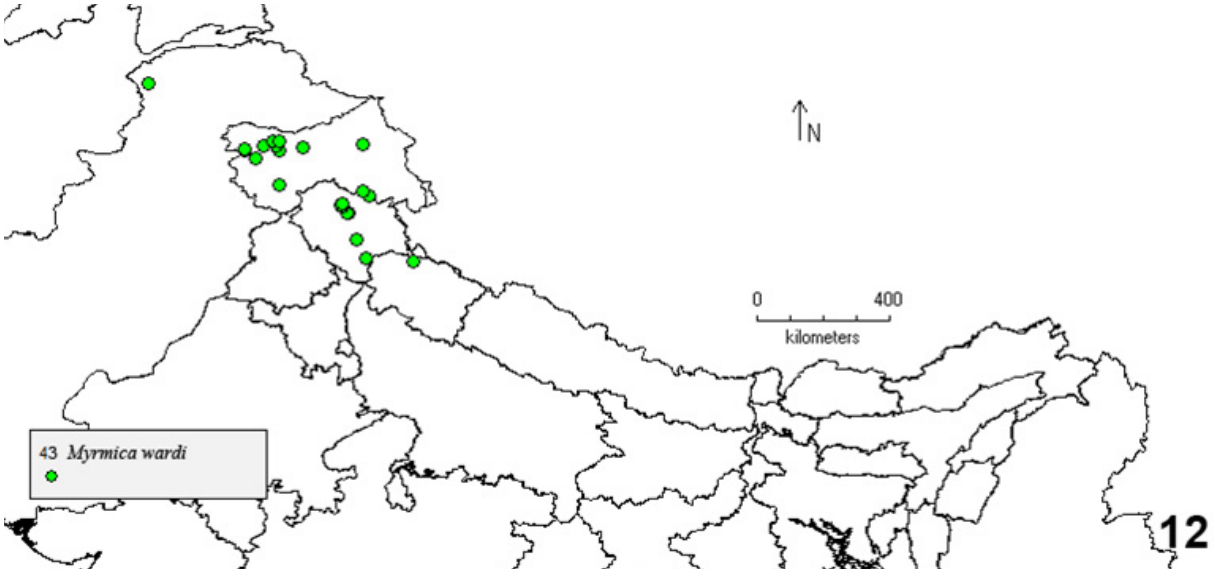
Myrmica aimonissabaudiae Menozzi, 1939
= *Myrmica dicaporiaccoi* Menozzi, 1939, synonymy by Radchenko and Elmes, 2001.
Lectotype of *Myrmica aimonissabaudiae* (designated by Radchenko & Elmes, 2001)**:** worker, "Karakorum, Gund, Valle Sind, 2080m, 9.iv.1929" (MSNM);
Paralectotypes (designated by Radchenko & Elmes, 2001): 3 workers, "Karakorum, Gund, Valle Sind, 2080m, 9.iv.1929" (MSNM); 1 gyne, "Askol, Braldo, 3100m, 10.viii.1929" (MSNM);
Lectotype of *M. dicaporiaccoi* (designated by Radchenko & Elmes, 2001), worker, "Sped. Karakorum, Shigar, 23.viii.29, 2200m" (MSNM).

Distribution

(a) India: ***Uttarakhand*:** Mana 3200m (1), Badrinath 3100m (1), Flower Valley 3500m (1), Ghangria 3500m (1), Chakrata 3000m (1); ***Himachal Pradesh*:** Badhal 2090m (1), Manali 1900-2063m (1, 2), Kothi 2440-2538m (1), Manikaran 1778m (1), Naddi 1829m (1), Nalivan 2280-2300m (1), Narkanda 2710m (1), Old Manali 2243m (1), Pattidhank 2440m (1), Snaba 2440m (1), Solang 2460-2730m (1), Sissu 3200m (1), Bhaggi 2700m (1), Kharapathar 2700m (1), Koholara 2200m (1), Prounthi 2280m (1), Khinang Village 2940m (1), Roggling 2740m (1), Tingrit 3150m (1), Tindi 2500m (1), Trilokinath 2760m (1), Mohri 3000-3200m (2), 3km E Fagu, 20km E Shimla 2300m (2), Theong 25km E Shimla 2400m (2), Kullu valley, Manali 2000m (2), Kullu valley, 5-7km SW Rottang La Pass 2500-2900m (2), Kullu valley vic. Nagga, 20km SW Manali 1500-1600m (2); ***Jammu and Kashmir*:** Aharbal 2029m (1), Aru 2453m (1), Babarishi 2359m (1), Dachigam 1678m (1), Drang 2229-2231m (1), Gulmarg 2650-3000m (1, 2), Kargil 2650m (1), Kokernag 1912m (1), Kongdoori 2880m (1), Mughal garden 1670m (1), Pahalgam 2190-3100m (1, 2), Patnitop 1973m (1, 2), Sarthal 2390-2393m (1), Seven Springs 3077m (1, 2), Shopian 2029m (1), Tangmarg 2160m (1, 2), Verinag 1875m (1), Yusmarg 2380-2390m (1), Daksum 2400-2700m (2), Lidderwat 2459-2700m (1, 2), Kulan-Shrinagar 2100m (2), Ladakh (Chellong River 3360m (2), Panikhar, Suru riv. 3150m (2), Leh 3450m (2), Khalsi 2950m (2)), Sonamarg 2700m (2), Dahigam Game Sanctuary 1650m (2); ***Arunachal Pradesh*:** Bomdila 2430m (1); ***West Bengal*:** Darjeeling (Bharapabec Lebong 1800-1900m (2)); ***Sikkim*:** Taungloo 3048m (2); ***Meghalaya:*** Shillong (2).



Map 11. Known distribution of *Myrmica latra, M. vittata*, *M. rugosa*.

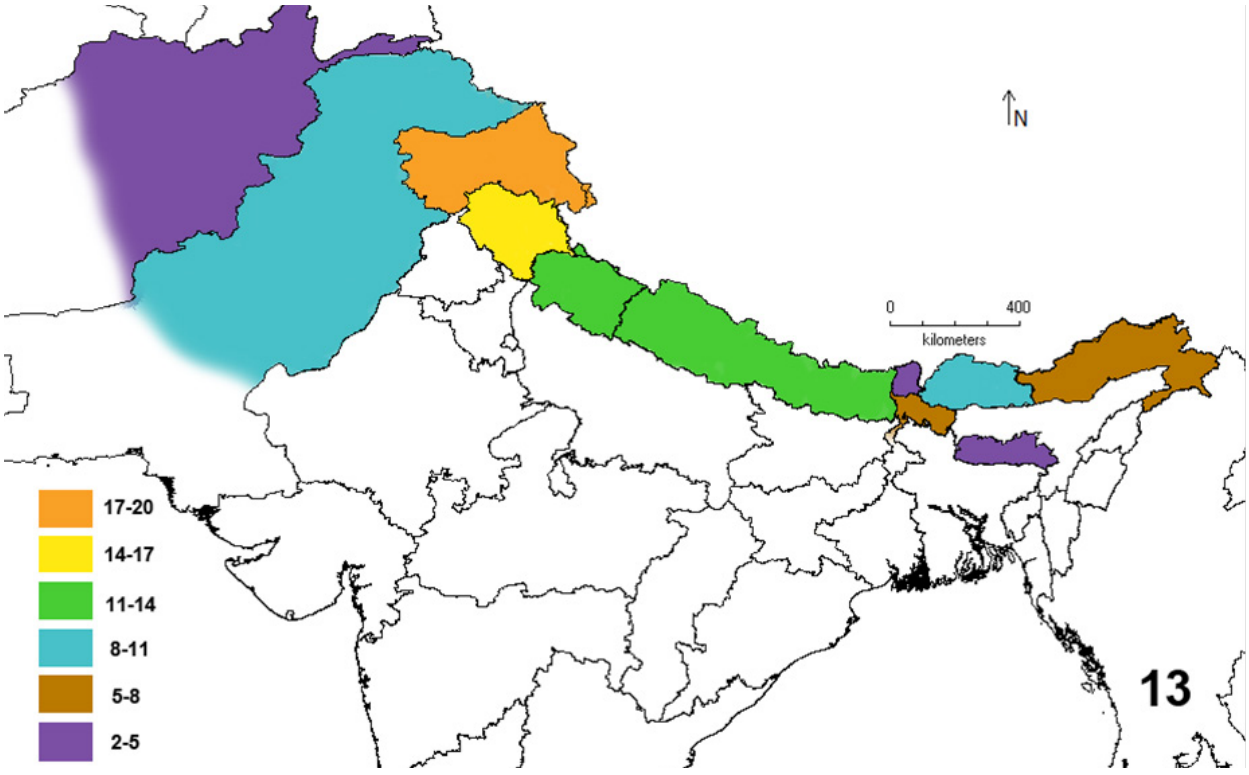


Map 12. Known distribution of *Myrmica wardi.*

(b) Nepal: Lumleek (2), Ghasa-Tukhe, Larjung, 16km SW Jomosom 2550m (2).
(c) Bhutan: Gogona 3100m (2), Nobding, 41km O Wangdi Phodrang 2800m (2), Wangdi Phodrang 1300m (2).
(d) Pakistan: Shagram, Khagan valley 2200-2750m (2), Kalam 2300m (2), Changla Gali, between Muree and NathiaGali 2200m (2), Naran (2), Maduglarht (2), Shogram (2).
(e) Afghanistan: Lalma (2), Walang, Salangtal 2550m (2), Paghman (2).
Ecology: This species has a widespread distribution in Himalaya, occupying a variety of habitats, under stones, rotten wood, near the foot of trees, riverine habitats and nests in open meadow mostly in *Pinus*, *Cedrus* and *Juniperus* forests. The nests of this species are polydomous, with the internal temperature ranging from 14°C to 28°C, and thrive well in disturbed habitats with considerable anthropogenic activities. Large nests were observed to contain more than 200 workers including alates (both males and gynes) were observed in June and as late up to first week of August. The altitudinal range for the species in Himalaya is 1300m to 3500m above mean sea level.

Myrmica alperti Elmes et Radchenko, 2009
Holotype: worker, "Nepal, 3200m, Thodung, 2-9.iv.1973 (leg. J. Martens), Coniferenwald", "*M. indica* Weber det. Radchenko and Elmes", NHMB);
Paratypes: 14 workers "Nepal, 3200m, Thodung, 2-9.iv.1973 (leg. J. Martens)"; 9 workers, "Nepal, Jiri-Thodung, 28.V.1976 (leg. W. Wittmer and C Baroni Urbani)", "*M. indica* Weber det. Radchenko and Elmes"; 1 worker, "Nepal, Shiralaybis, Jiri-grat, 2200 m, 8.vi.1973 (leg. J. Martens)", "*M. indica* Weber det. Radchenko and Elmes" (NHMB, SIZK, GEPC).
Distribution: Nepal (3).
Ecology: Virtually unknown, except that the type series of this species was found at altitudes between 2200 and 3200m above mean sea level.

Myrmica boltoni Radchenko et Elmes, 1998
Holotype: worker, "Nepal, Dhorpantan, 3000m, 20.v.1973, leg. T. Martens" (NHMB); **Paratypes:** 15 workers "Nepal, Dhorpantan, 3000m, 20.v.1973, leg. T. Martens" (probably same nest); 3 workers, "Nepal Umg. Goropani, w. Pokhara, Zentral Nepal, Sept.-Oct. 1971, leg. H. Franz"; 1 worker, "Nepal, 2 miles, S.E. Sikha, 7800-8000fts., 21-22.v.1954, leg. J. Quinlan"; 1 worker, "Nepal, 18 km NNE Baglung, 28°24'N, 83°42'E, 2540m 29.xi.1988 No.9619 leg. Ward"; 1 worker, "Nepal-23, Prov. Kosi, Distr. Sankhuwasawa, Vallee d'Induwa Koa, 2000m, 16.iv.1984, leg. Lobl and A. Smetana"; 1 worker, "Nepal-140, Prov. Manang, Marsyandi, 2550m, 14-17.iv.1980, leg. J. Martens and Ausobsky"; 2 workers, "Nepal-161, Prov. Mustang, Lethe, 2450-2600m, 30.iv.1980, leg. J. Martens and Ausobsky"; 1 worker, "Nepal-233, Prov. Gorkha, Chuing Khola, Meme Kharka, 3300-3400m, leg. J. Martens and W. Schwaller" (NHMB, BMNH, SIZK, GEPC, PSWC, JMPC, ASPC).
Distribution: Nepal (2).
Ecology: Almost unknown, but one worker was collected under rotten wood in a *Quercus-Rhododendron* forest. All samples were collected at altitudes between 2000m and 3400m above mean sea level.



Map 13. Species richness based on nominal *Myrmica* species for the regions considered in the study.

Myrmica brancuccii Radchenko, Elmes et Collingwood, 1999
Holotype: worker, "Nepal, Utrot, 13.v.1983, leg. M. Brancucci" (BMNH);
Paratypes: 5 workers, with the same label as holotype; 14 workers, "Nepal, Lawarai, 21.05.1983, leg. M. Brancucci"; 1 worker, "Nepal, Lumie, vi.1988, leg. Collingwood"; 9 workers, "Pakistan, Chitral V., between Dir and Lavari Pass, 2400m, 11.viii.1994, leg. S. Dakatra" (BMNH, NHMB, CAC, MSNM, SIZK, GEPC).
Distribution: Nepal and NE Pakistan (2).
Ecology: Virtually unknown, except that one sample was collected at an altitude 2400m above mean sea level.

Myrmica cachmiriensis Forel, 1904
= *Myrmica smythiesi* var. *lutescens* Menozzi, 1939 (first available use of *Myrmica smythiesii* r. *cachmiriensis* var. *lutescens* Forel, 1904)
Lectotype of *M. cachmiriensis* (designated by Radchenko & Elmes, 2001)**:** "Kashmir, Sind Valley, 9500ft (Wroughton)", "*M.smythiesii* v. *kashmiriensis* Forel, type" (MHNG);
Paralectotypes (designated by Radchenko & Elmes, 2001)**:** 2 workers with same labels as lectotype (MHNG); 1worker, "*M.smythiesii* For. var. *kaschmiriensis* w type Sind Valley, 7500' Kaschmir (Wroughton) Jh.6" (MSNG);
Lectotype of *M. smythiesi* var. *lutescens* (designated by Radchenko & Elmes, 2001): worker, "Cachmire (Smythies)", "*M. smythiesi* For. r. *cachmiriensis* For. v. *lutescens* For., type" (MHNG).
Distribution
(a) India: *Jammu and Kashmir*: Seven Springs 3077m (1), Patnitop 1973m (1), Aru 2500m (2), Pahalgam 2100-2190m (2), Kulan 2100m (2), Daksum 2400-2700m (2), Gulmarg-Tangmarg 2300-2650m (2), Tusmarg 2300-2400m (2); ***Himachal Pradesh*:** Naddi 1829m (1), Solang 2480-2677m (1), Kothi 2420-2441m (1), Gulaba 2800m (1).
(b) Pakistan: Kagan Valley, Shogran 2300-2600m (2), Changlu Gali between Mure and Nathia Gali 2200m (2), Sobodan Gali (Bagh) 2300m (2).
Ecology: This species forms small nests (with 10-50 workers) under stones in soil covered with scattered vegetation. However, few nests were found in dense forests in soil covered with leaf litter. These ants appear to prefer shady areas, as they were never observed in exposed habitats. Nest temperature ranged from 14°C to 22°C and relative humidity 91%. Alates were observed during July and August. Altitudinal range for this species is 1829 to 3500m above mean sea level.

Myrmica collingwoodi Radchenko et Elmes, 1998
Holotype: worker, "Bhutan, Dorjula, 3100m, 26.06.1972, Nat. Hist. Museum BASLE - Bhutan Expedition 1972, Alk. No 56" (NHMB);
Paratypes: 9 workers, 1 queen, "Bhutan, Dorjula, 3100m, 26.06.1972, Nat. Hist. Museum BASLE - Bhutan Expedition 1972, Alk. No 56"(probably same nest); 6 workers, "Bhutan, Dorjula, 3100m, 6.06.1972, Nat. Hist. Museum BASLE - Bhutan Expedition 1972, Alk. No 56"; 6 workers, "Dorjula, 2450-3100m, 6.06.1972, Nat.-Hist. Museum BASLE - Bhutan Expedition 1972, No 24-36" (NHMB, BMNH, SIZK, GEPC).
Distribution: Bhutan (2).
Ecology: Virtually unknown, except that this species was found at altitudes ranging 2450-3100m above mean sea level.

Myrmica curvispinosa Bharti et Sharma, 2013
Holotype: worker, "India, Himachal Pradesh, Shoja, 31.568 069°N, 77.372096°E, 2700m, 10.ix.2008" (PUAC);
Paratypes: 85 workers and 2 gynes, same colony as the holotype; 1 worker and 1 intercaste, "India, Himachal Pradesh, Kothi, 32.319325°N, 77.197945°E, 2479m, 16.vi.2003" (PUAC).
Distribution: India: Himachal Pradesh (1).
Ecology: *Myrmica curvispinosa* was manually collected from a nest under stones, found in a patchy *Cedrus* forest located in a temperate region of the Himalaya. The forest was surrounded by cultivated fields and an apple orchard. The temperature recorded at the site was 23°C. One paratype (intercaste) was collected from another locality (Kothi), beneath a stone in moist soil, in a grass-covered area surrounded by a patchy *Cedrus* forest.

Myrmica elmesi Bharti et Sharma, 2011
Holotype: worker, "India, Jammu and Kashmir, Machedi, 32.72364°N, 75.669464°E, 2000 meters, collected 3rd August, 2008" (PUAC);
Paratypes: 1 worker with same data as of holotype and 10 workers "India, Jammu and Kashmir, Sarthal, 32.812947°N, 75.762503°E, 2200 metres" (PUAC).
Distribution: India: Jammu & Kashmir (1).
Ecology: The type series of this species was collected from leaf litter in both the habitats. The collection site at Machedi has a patchy *Cedrus* forest along with agricultural land surrounding the site; moreover, the area has lot of anthropogenic pressure (in terms of grazing and cropland management) with a dry type of environment (mean temperature during collection period 32°C, relative humidity 36.62%, annual rainfall 970mm and thickness of leaf litter 2.1cm). The collection site at Sarthal has dense *Cedrus* forest with abundant leaf litter, no agricultural land, and has very limited anthropogenic activities with only nomads visiting the area. The site is usually snow covered from November to beginning of March (mean temperature during collection period 22°C, relative humidity 66.38%, annual rainfall 1476mm and thickness of leaf litter 3.9cm).
The area where this species is distributed is a transitional zone between subtemperate and temperate Himalaya, penetrating into the Palearctic zone (whose boundary in Southern Asia is largely altitudinal, where an altitude of 2000–2500 meters above mean sea level forms the boundary between Palearctic and Indo-Malayan ecozones) (Bharti & Sharma, 2011a).

Myrmica ereptrix Bolton, 1988
Holotype: gyne "Holotype female, India: Kashmir, Gulmarg, 20.vii.1986, 2800m, *Picea* forest, leg. P.H. Williams" (BMNH).
Distribution: India: Jammu & Kashmir (2).
Ecology: This species was collected from *Picea* forest.

Myrmica foreliana Radchenko et Elmes, 2001 (replacement name for *Myrmica smythiesii*
r. *carbonaria* Forel, 1902)
Holotype: worker, "Himalaya, Pachmarhi, Shurr, 30.vii.93, leg. Rothney" (MHNG).
Distribution: India: *Uttarakhand*: Chopta, 2900m (1).
Ecology: Queen and workers were collected under a stone during the month of May, when temperature of Chopta Valley was 23˚C and humidity 75%. This region has alpine vegetation, with orchids, *Rhododendron* and other high-altitude vegetation.

Myrmica fortior Forel, 1904
Lectotype (designated by Radchenko & Elmes, 2001): worker, "India, Sind Valley, 6500 ft, Kashmir (Wroughton), var. *fortior* Forel" (MHNG);
Paralectotypes (designated by Radchenko & Elmes, 2001): 2 workers "India, Sind Valley, 6500 ft, Kashmir (Wroughton), var. *fortior* Forel" (MHNG); 1 worker, "*Smythiesi* var. *fortior* Sind Valley" (MSNG).
Distribution: India: *Jammu & Kashmir*: Pahalgam 2100-2202.5m (1, 2), Yusmarg 2380m (1), Babarishi 2359m (1), Aru 2450-2500m (1, 2), Shopian 2029m (1), Seven Springs (Srinagar) 3077m (1), Sonamarg 2700m (2), Daksum 2400-2700m (2), Lidderwatt 2700m (2); Shankarachayra (2), Sorale San, Kangwan-do (2).
Ecology: This species was commonly observed nesting under stones in grasslands, pine forest and at the edge of spruce-fir grooves. Nesting sites had temperature ranging from 20˚C in Babarishi to 25˚C in Pahalgam and humidity from 51% in Babarishi to 57% in Yusmarg. Average nest temperature was found to be 33˚C.

Myrmica hecate Weber, 1947
Lectotype (designated by Radchenko & Elmes, 2001): worker: "India, Himalaya, Darjeeling, Botanical gardens, 6900 ft, 7.viii.09, No.8609-19, Pavia" (MCZ);
Paralectotype (designated by Radchenko & Elmes, 2001): worker (damaged, without postpetiole and gaster), "Darjeeling, 6000 ft, 24.x.1909. No.8607-19, Brunetti" (MCZ).
Distribution
(a) India: *Himachal Pradesh*: Solang 2610m (1), Marhi 3334m (1), Kothi 2400m (1), Manali, Oalti Kumal (2), Chopal-Khangna Nallah 2250m (2), Kullu Valley, 2-4km SW Rothang La, Pass 3400-3700m (2); ***Jammu & Kashmir:*** Yusmarg 2300-2400m (2); ***Uttarakhand:*** Chakrata 3000m (1); ***West Bengal*:** Darjeeling (1, 2), Happy Valley 1880m (1), Mirik 2080m (1), Sukhia 2000m (1), Kalingpong 1850m (1), Tiger hills (2), Bhara patee Lebong 1800-1900m (2), Ihepi 1300-1400m (2); ***Sikkim:*** Phadamchen 1710m (1) (East Sikkim); ***Arunachal Pradesh*:** Bomdila 2430m (1).
(b) Nepal: Lumle (2), Baira Bali von Katmandu (2), Daman 2400m (2).
Ecology: The nests of this species were found under stones in grasslands and in soil covered with scarce to dense vegetation. Nest temperature and humidity ranged from 24.4-28˚C and 45% to 90%, respectively. Large colonies contained more than 200 workers. Alates of this species occasionally appear as late as in September in Northeast Himalaya. The altitudinal range for this species is 1300m to 3700m above mean sea level.

Myrmica indica Weber, 1950
Lectotype (designated by Radchenko & Elmes, 1998): worker, "Tonglu, E. Himalayas, 10,000 ft., 22.04.10 (C. W. Beebe)" (MCZ);
Paralectotype (designated by Radchenko & Elmes, 1998): 2 workers, with the same label as lectotype (MCZ).
Distribution
(a) India: *West Bengal*: Darjiling, Tigerhills 2500m (2); ***Arunachal Pradesh*:** Tawang 2660m (1).
(b) Nepal: Chordung, Jiri 2900m (2), Thodung (2), Shiralaybis, Jiri-grat 2200m (2), Jiri-Thodung (2), Phulchoki 2600m (2), Zentral-Nepal, Zw.Tare-Pati, u.Gasaikunde (2), Taplejung, Simbua Khola, vicinity Lassetham 3000-3150m (2), Prov. Sankhua, Sabha, vic. Phakhola 2600-2800m (2), Maeva Khola, Sanghu (2), Chautra, Nanling Lekh 2895m (2), Phulkhola 2743m (2).
(c) Bhutan: Thimphu (2), Sampa-Kotoka 1400m-2600m (2), Nobding, 41km O Wangdi 2800m (2).
Ecology: Poorly known, this species lives in open forests at an altitude of about 2500m above mean sea level (Radchenko & Elmes, 2010).

Myrmica inezae Forel, 1902
Holotype: worker, "Himalaya, Pachmarhi (Schurr)" (MHNG).
Distribution
India: *Uttarakhand*: Chourangi Khaal 2300m (1), Mussorie 1900m (2); ***Himachal Pradesh*:** Solang 2590-2734m (1), Manali 1826-3000m (2), Chopal 2400-2750m (2), vic. Theong 25km E Shimla 2400m (2).
Ecology: Colonies of *Myrmica inezae* were found nesting under stones and in rotten logs at shady places. These areas are covered with *Cedrus* and *Pinus* trees with very dense ground vegetation. Lowest and highest air temperature observed at the collection site was 21.4˚C and 30˚C, respectively, the nest temperature never exceeding 17˚C. Humidity of the collection site ranged from 54% to 79%. Alates appear in June and July. The altitudinal range for this species is 1900-3000m above mean sea level.

Myrmica kothiensis Bharti et Sharma, 2013
Holotype: worker, "India, Himachal Pradesh, Kothi, 32.31 9325°N, 77.197945°E, 2479 m, 16.vi.2003" (PUAC);
Paratypes: 3 workers from the nest of holotype (PUAC).
Distribution: India: Himachal Pradesh (1).
Ecology: This species was collected from a grass-covered site with a patchy *Cedrus* forest. The workers were found nesting under a stone in moist soil, on a shady mountain slope. The recorded nest temperature was 20˚C.

Myrmica kozlovi Ruzsky, 1915
= *Myrmica kozlovi* subsp. *mekongi* Ruzsky, 1915, synonymy by Radchenko and Elmes, 2010
= *Myrmica kozlovi* subsp. subbrevispinosa Ruzsky, 1915, synonymy by Radchenko and Elmes, 2010
= *Myrmica kozlovi* subsp. *subalpina* Ruzsky, 1915, synonymy by Radchenko and Elmes, 2010
= *Myrmica specularis* Donisthorpe, 1929, synonymy by Radchenko and Elmes, 2001
Lectotype of *M. kozlovi* (designated by Radchenko & Elmes, 2010) 1 worker, "tributary of riv. Dza-chju, Kam, riv. Yangtze, 12-13000', leg. Kozlov, beginning of iii.01" (original label in Russian) (ZISP);
Paralectotypes (designated by Radchenko & Elmes, 2010): 34 workers "tributary of riv. Dza-chju, Kam, riv. Yangtze, 12-13000', leg. Kozlov, beginning of iii.01"; 27 workers, "valley of riv. Yangtze, Kam, Tibet, leg. Kozlov, iii.01"; 1 worker, "riv. Dza-chju, 11000', Kam, basin of riv. Yangtze, leg. Kozlov, middle of iv.01"; 10 workers, "riv. Dza-chju, riv. Yangtze, 12-13000', leg. Kozlov, beginning of v.01" (all original labels in Russian) (ZISP, ZMMU, SIZK);
Lectotype of *M. kozlovi* subsp. *mekongi*, (designated by Radchenko & Elmes, 2010): worker, "riv. Bar-chju, basin of riv. Mekong, Kam, end of ix.1900, leg. Kozlov" (original label in Russian), "*Myrm. kozlovi* sub. *mekongi* n. sub. M. Ruzsky" (ZMMU);
Paralectotypes (designated by Radchenko & Elmes, 2010): 15 workers "riv. Bar-chju, basin of riv. Mekong, Kam, end of ix.1900, leg. Kozlov"; 1 worker, "riv. Ba-chju 12,000' Kam, basin of riv. Yangtze, leg. Kozlov, 2-3.viii.00" (original label in Russian) (ZMMU, ZISP, SIZK);
Holotype of *M. kozlovi* subsp. *subbrevispinosa,* worker, "valley of riv. Yangtze, Kam, Eastern Tibet, leg. Kozlov, iii.01" (original label in Russian), "*M. kozlovi* v. *subbrevispinosa* n. var." (ZMMU);
Holotype of *M. specularis,* worker, "Tibetan side of the Mt. Everest: Tibet, Gautsa, 13000 ft, 5.iv.1924" (Hingston) (BMNH);
Paratypes: 4 workers "Tibetan side of the Mt. Everest: Tibet, Gautsa, 13000 ft, 5.iv.1924" (BMNH).
Distribution
(a) India: ***Sikkim:*** Khamba Jong 4572-4876m (2); ***West Bengal*****:** Darjiling, Tigerhills 2500m (1); ***Arunachal Pradesh*****:** Tawang 2660m (1).
(b) Tibet: S E Tibet, Dzogang 2743-4267m (2).
Ecology: According to Radchenko and Elmes (2010), "the ecology of this species is poorly known. It has been found at the highest altitudes recorded for any *Myrmica* species recorded worldwide (4800m) which accounts for it being the only *Myrmica* species that has crossed the Himalayan barrier to live on both the Western and eastern slopes". Donisthorpe (1929) wrote that "According to Major Higston (the collector of *M. specularis*) the ants found at the higher elevations (in the Himalaya) are exceedingly lethargic and sluggish in their movements".

Myrmica latra Bharti, Radchenko et Sasi, 2016
Holotype: queen, "India, Himachal Pradesh: Prounthi, 31.1043, 77.6487, 2260m, Hand picking, 14 July 2013, Joginder Singh leg." (PUAC);
Paratype: male (alate), "India, Himachal Pradesh, Roggling, 32.5514, 76.9704, 2740m, 12 July 2015, Pawanpreet Kaur leg." (PUAC).
Distribution: India: Himachal Pradesh (1).
Ecology: Both queen and male were collected from nests of *M. aimonissabaudiae* built under stones. The ground was covered with low vegetation, and scattered *Pinus* and *Cedrus* trees. The recorded nest temperature and humidity at site one, where queen was collected was 18˚C and 76%, whereas at site two where male was collected the recorded nest temperature was 19˚C and humidity 66% (Bharti et al., 2016b).

Myrmica longisculpta Bharti et Sharma, 2011
Holotype: worker, "India, Jammu and Kashmir, Sarthal, 32.812947°N, 75.762503°E, 2200m a.s.l., 15.vi. 2009, coll. Sharma" (PUAC);
Paratypes: 4 workers "India, Jammu and Kashmir, Sarthal, 32.812947°N, 75.762503°E, 2200m a.s.l., 15.vi. 2009, coll. Sharma", not from same nest; 1 worker, "India, Jammu and Kashmir, Machedi, 32.72364°N, 75.669464°E, 2000 m a.s.l., 3.viii.2008 (coll. Sharma)", 1 worker, "India: Jammu and Kashmir**:** Shopian, 33.668354°N, 74.779472°E, 3100 m a.s.l., 12.ix.2009, coll. Sharma" (PUAC).
Distribution: India: Jammu & Kashmir (1).
Ecology: All the known type material of this species was hand-collected from two localities (Sarthal, 32.812947°N,75.762503°E, 2200m a.s.l and Shopian, 33.668354°N, 74.779472°E, 3100m a.s.l.) and from leaf litter submitted to Winkler's extractor at another locality (Machedi, 32.72364°N, 75.669464°E, 2000m a.s.l.). The collection site at Machedi has a patchy *Cedrus* forest surrounded by agricultural land; moreover, the area has a lot of anthropogenic activities with dry type of environment (mean temperature during collection period 32˚C, relative humidity 36.62% and thickness of leaf litter 2.1cm). The collection site at Sarthal has dense *Cedrus* forest with abundant leaf litter and no agricultural land. It remains snow clad from November to the beginning of March and has very limited anthropogenic activities with only nomads visiting the area (mean temperature during collection period 22˚C, relative humidity 66.38%, thickness of leaf litter 3.9cm) with a comparatively wet environment. At the third collection site (Shopian), specimens were collected under a stone. The area has scattered *Cedrus* trees, as the forest has largely been cleared by human activities. The mean temperature and relative humidity recorded during collection period was 22˚C and 54%, respectively. (Bharti & Sharma, 2011c).

Myrmica martensi Radchenko et Elmes, 1998
Holotype: worker, "Nepal, Gosainkund, Sing Gyang, 3200 m, 26.04.1973, leg. J. Martens" (BASLE);

Paratypes: 3 workers, 1 queen, with same label (probably same nest) as holotype (NHMB).
Distribution: Nepal (2).
Ecology: unknown.

Myrmica nefaria Bharti, 2012
Holotype: gyne, "India, Himachal Pradesh, Solang Valley (32.312° N, 77.1556° E), 2469 meters a.s.l., 20.vi.2010, leg. H. Bharti" (PUAC);
Paratypes: 62 gynes, 5 workers, 4 males, all from the nest of holotype (PUAC).
Distribution: India: Himachal Pradesh (1).
Ecology: As per Bharti (2012a), "The nest of the host species *M. rupestris* with *M. nefaria* was found under a stone, in open grassland with bushes, shrubs, broadleaf trees and widely scattered coniferous trees; the recorded air temperature was 30°C and the relative humidity was 68% at the site. Topographically, this valley has two very distinct areas, which differ quite significantly in their environmental conditions. The area which is directly exposed to sun is rock-strewn, dry, with only patches of grass (without herbs or shrubs) and harbors maximum abundance of *Formica* species. The other area is comparatively wet, shady, with ample vegetation, and has more *Myrmica* species together with some patches occupied by *Temnothorax*, *Lasius*, and *Formica* species. The region of Solang Valley represents the temperate zone of Himalaya and remains snow covered from December to March. Additionally, the region typifies the transitional zone between Greater Himalaya and Trans Himalaya and harbors a rich diversity of flora of both ecological conditions mentioned and is rich in endemic plants."

Myrmica nitida Radchenko et Elmes, 1999
Holotype: worker, "Kashmir, 1km. N.E. Yehmer Pass, 34°13'N, 75°10'E, 3600m, 06.08.1978, leg P.Ward, acc. No 3044: alpine vegetation, under stone" (BMNH);
Paratypes: 9 workers from the nest of holotype; 17 workers, 4 gynes, 2 males, "Kashmir, Sanang, 2600-2750 m, leg. W. Wittmer" (BMNH, NHMB, PSWC, SIZK, GEPC)
Distribution: India: ***Jammu and Kashmir*** & ***Himachal Pradesh***: Keylong 3100m (1).
Ecology: *M. nitida* is distributed in alpine zone of Northwest Himalaya. The nests are located under stones in grasslands with scattered *Juniper* and *Rhododendron*, with ground cover of herbs and shrubs. The recorded nest temperature and humidity was 23.6°C and 89%, respectively. The altitudinal range for this species is 2600-3600m above mean sea level.

Myrmica ordinaria Radchenko et Elmes, 1999
Holotype: worker, "India: Kashmir, Seven Springs, 29.07.86 leg. P.Williams" (BMNH);
Paratypes: 23 workers, 1 queen, "India: Kashmir, Seven Springs, 29.07.86 leg. P.Williams" (probably same nest); 6 workers, "Pakistan, Kalam, 2300m, 12.07.94, leg. S.Dakatra" (BMNH, NHMB, MSNM, SIZK, GEPC).
Distribution: India and Pakistan (known only from the type series) (2).
Ecology: Unknown.

Myrmica pachei Forel, 1906
Lectotype (designated by Radchenko & Elmes, 2001): worker, "NE Nepal, Tseram, 3600 m, Pache" (NHMG).
Paralectotypes (designated by Radchenko & Elmes, 2001): 2 workers (NHMG) and 1 worker "NE Nepal, Tseram, 3600 m, Pache" (MCZ); 1 worker, 1 male, "*Myrmica Pachei* n. Nepal, Himalaya 3600 m" (MSNG).
Distribution:
(a)India: ***Arunachal Pradesh*****:** Jaswantgarh 3146-3180m (1).
(b)Nepal: Prov. Taplejung, upper Simbu Khola Valley, vic. Tseram 3250-3350m (2), Prov.Taplejung, Dhara und Alm Lasea 3000-3300m (2).
(c)Bhutan: Nobding, 41km O Wangdi 2800m (2), Kotoka-Gogona 2600-3400m (2), Doriula 3100m (2).
Ecology: This species was found nesting under stones in wet soil, with ground covered with grass, low vegetation and scattered *Pinus* trees. The maximum altitude at which specimens were collected was 3180m (Jaswantgarh in Arunachal Pradesh), where temperature ranged from 15°C to 24.2°C and humidity 65-85%. The colonies were small with up to 30 workers. Alates were collected during the month of June and first week of October.

Myrmica petita Radchenko et Elmes, 1999
Holotype: queen, "Kashmir, Yusmar 2300-2400m, 6.vii.1976, leg. W. Wittmer" (NHMB).
Distribution: India: Kashmir (2).
Ecology: unknown.

Myrmica pseudorugosa Bharti, 2012
Holotype: worker, "Pakistan, Kaghan valley, Gittidas, 3600 meters a.s.l., 17.ix.2005 (Seiki Yamane coll. code = PK05-SKY-42)" (PUAC);
Paratypes: 3 workers, collected from the same nest (BMNH; PUAC). Approximate GPS coordinates 35.1167°N–73.9833°E.
Distribution: Pakistan (1).
Ecology: This species has been collected at an altitude of 3600 meters a.s.l., which represents the trans-Himalayan alpine zone, corresponding to a dry desert area above the timberline.

Myrmica radchenkoi Bharti et Sharma, 2011
Holotype: worker, "India, Jammu and Kashmir, Machedi, 32.72364°N, 75.669464°E, 2000 meters above msl, 3rd August, 2008" (PUAC);
Paratypes: 3 workers and 1 queen "India, Jammu and Kashmir, Machedi, 32.72364°N, 75.669464°E, 2000 meters above msl, 3rd August, 2008" (PUAC).
Distribution: India: Jammu & Kashmir (1).
Ecology: This species was collected from leaf litter in a

patchy *Cedrus* forest, and the area is a transitional zone between temperate and subtemperate Himalaya. The ambient temperature at the collection site was 32˚C and the nest temperature was 30˚C (Bharti & Sharma, 2011b).

Myrmica religiosa Bharti et Sharma, 2013
Holotype: worker, "India, Uttarakhand, Chourangikhaal, 30.683614°N, 78.432684°E, 2300 m, 02.vi.2010" (PUAC);
Paratypes: 20 workers from the nest of holotype (PUAC).
Distribution: India: Uttarakhand (1).
Ecology: *Myrmica religiosa* was manually collected living under stones in a dry forested area of Chourangikhaal. The trees like *Cedrus*, *Quercus*, *Rhododendron* and *Pinus* predominate the area. The area has numerous anthropogenic activities. The recorded temperature and humidity at the collection site was 30˚C and 65%, respectively.

Myrmica rhytida Radchenko et Elmes, 1999
Holotype: worker, "Kashmir, Up. Kainthal Nar, 34º00'N, 75º45'E, 3750 m, No. 3061, 14.viii.1978, leg. P.Ward" (BMNH).
Paratypes: 113 workers and 32 males from same nest of holotype; 3 gynes, 4 males, "Kashmir, 3 km NE Tar Sar, 34º09'N, 75º11'E, 3300 m, No. 3037, 02.08.1978, leg. P. Ward"; ~220 workers, 10 queens, 5 males, "Kashmir, TarSar, 34º09'N, 75º09'E, 3950 m. No.3038, 3039, 3040, 3041, 3042, 4.viii.l978, leg. P. Ward"; 25 workers, "Kashmir, 1Km NE Yehmer Pass, 34º13'N, 75º10'E, 3600 m, No.3043, 3045, 06.viii.1978, leg. P. Ward"; 84 workers, 7 queens, 4 males, "Kashmir, 4km S Kulan, 34º14'N, 75º10'E, 3599 m, No.3046, 3048, 07.viii.1978, leg. P. Ward"; 3 workers, "Kashmir, Sain Nar, 34º06'N, 75º34'E, 3750 m, No.3054, 11.viii.1978 leg. P. Ward"; 4 workers, 1 gyne, 4 males, "Kashmir, Wampet, 34º04'N, 75º37'E, 3700m, No.3057, 12.viii.l978, leg. P. Ward"; 1 male, "Kashmir, Up. Kaintal Nar, Oitto, 34º00'N, 75º45'E, 4200 m. No.3068, leg. P. Ward"; 3 workers, "India, Beastel, 20km S Rhotang, 2800 m, No. J 23, 18.viii.1990, leg. J. Heinze". (BMNH, NHMB, IZK, MSNM, ASPC, PSWC, GEPC, MMPC).
Distribution: India: ***Jammu and Kashmir*** & ***Himachal Pradesh***: Sagnam 3600m (1).
Ecology: *M. rhytida* is found at an altitudinal range of 2800m and 4200m in Himalaya. Nests are built in the soil (often under stones) and in birch logs. It inhabits alpine meadows often containing juniper species, dry alpine scrub and birch trees and at the edges of birch forests at an altitude where *Rhododendron* begin to appear. The nest temperature at one of the collection site (Sagnam) was 31˚C and relative humidity 41%. It is primarily distributed above timberline in cold desert regions of Himalaya, with low pluviosity. There are records of sympatry between *M. rhytida* and *M. wardi*, but *M. rhytida* tend to live at higher altitudes in comparison to the latter (mean of 3600m vs. 2700m). There are records of this species tending root aphids inside several of its nests. The foraging behaviour of *M. rhytida* appears to be quite cryptic, it stays close to the soil surface and was never found foraging on plants (Radchenko & Elmes, 2010).

Myrmica rigatoi Radchenko et Elmes, 1998
Holotype: worker, "Pakistan, Changla Gali (between Marree and Nathia Gali), 2200 m, 16.08.1994, leg. S. Dakatra" (MSNM).
Distribution: Pakistan: Changla Gali and Hazara Durgo Gal. 2300m (2).
Ecology: Unknown.

Myrmica rugosa Mayr, 1865
Lectotype (designated by Radchenko & Elmes, 2001): worker, "Himalaya", "*M. rugosa* Mayr" (ZMHB);
Paralectotypes (designated by Radchenko & Elmes, 2001): 1 worker, "Himalaya", "*M. rugosa* sp. n. Mayr" (BMNH); 1 worker, "*Myrmica rugosa* m. Himal."; 1 worker, "Himalaya Mayr e. c ej." (MSNG); 2 workers, "Himalaya", "Coll. Mayr" (original labels in Russian), "295" (ZMMU).
Distribution:
(a) India: ***Jammu & Kashmir:*** Seven Springs 3077m (1), Bhadarwah 1600m (1), Yusmarg 2390m (1), Pahalgam 2202m (1), Srinagar 1560m (2), Lidderwat 2150m (2); ***Uttarakhand:*** Kedarnath 3300m (1), Mana 3200m (1), Ghangria 3500m (1); ***West Bengal*****:** Darjeeling 1890m (1).
(b) Nepal: Thakkhola, Alt-Marsa 3100-3200m (2).
(c) Bhutan: 20km S Thimphu 2300-2440m (2), Sampa-Kotoka 1400-2600m (2), Doriula 2900m (2), Kotoka-Gogona 2600-3400m (2), Diechli Paka 3300m (2), Tanglu, 22km W Thimphu 2600-2800m (2), Para (2), Passeling 2700-3100m (2).
Note: Some of the material of "*M. rugosa*" has been cited to be collected in Kyrgyzstan (Jansen et al., 2010), well outside the limits of known geographic distribution of this species, which we consider doubtful (Bharti et al., 2016b).
Ecology: *Myrmica rugosa* nests were found under rotten wood at a forested site and under stones in grassland. Nesting sites had temperature ranging from 15˚C to 25˚C and humidity between 42% and 70%. The species seems to be well distributed in subalpine zone of Northwest Himalaya (3200m), which is dominated by the Himalayan maple (*Acer caesium*), west Himalayan fir (*Abies pindrow*), Himalayan white birch (*Betula utilis*), and Bell Rhododendron (*Rhododendron campanulatum*), with Himalayan yew (*Taxus wallichiana*), Himalayan lilac (*Syringa emodi*) and Hairy rowan (*Sorbus lanata*). Some of the common herbs are Jacquemont's Cobra Lily (*Arisaema jacquemontii*), *Boschniakia himalaica*, Kashmir Corydalis (*Corydalis cashmeriana*), Himalayan Jacob's Ladder (*Polemonium caeruleum*), Rampant tall weed (*Polygonum polystachyum*), Gigantic Himalayan Balsam (*Impatiens sulcata*), Wallich Geranium (*Geranium wallichianum*), Cleavers (*Galium aparine*), Himalayan Whorlflower (*Moringa longifolia*), Showy inula (*Inula grandiflora*), Yellow Himalayan lily (*Nomocharis oxypetala*), River Anemone (*Anemone rivularis*), Lousewort (*Pedicularis pectinata*), Horned

Lousewort (*P. bicornuta*), Drumstick Primrose (*Primula denticulate*) and Himalayan Trillium (*Trillium govanianum*). In this zone, *Myrmica rugosa* is found to be sympatric with *M. smythiesii*. The altitudinal range for this species is 1400m to 3500m.

M. rupestris Forel, 1902
= *Myrmica rugosa* var. *debilior* Forel, 1902, synonymy by Radchenko and Elmes, 2001
= *Myrmica rugosa* var. *rugososmythiesi* Forel, 1902, synonymy by Radchenko and Elmes, 2001
= *Myrmica everesti* Donisthorpe, 1929, synonymy by Radchenko and Elmes, 2001
Lectotype of *M. rupestris* (designated by Radchenko & Elmes, 2001), worker (upper specimen on the pin with 3 workers), "N-W Himalaya, Ekra Peak, 4400 ft (Smythies)", "LXXXIX/12, *M. smythiesii* For. v. *rupestris* For., Typus" (MHNG);
Paralectotypes: 2 workers on the same pin as lectotype (MHNG); 1 worker, "w *M. Smythiesii* For. var. *rupestris* Forel, Ekra Peak Himalaya" (MSNG);
Lectotype: worker of *M. rugosa* var. *debilior* (designated by Radchenko & Elmes, 2001), (upper specimen on the pin with 3 workers), "Himalaya (Smythies)", "LIX/4, *M. rugosa* r. *debilior*" (MHNG);
Paralectotypes (designated by Radchenko & Elmes, 2001): 2 workers on the same pin as lectotype (MHNG); 1 worker, with same labels as lectotype (UMO); 2 workers, "*M. rugoso-Smythiesii* Forel w Himalaya Smythies, LX/4", "var. *debilior* For." (MSNG); 3 workers, "Himalaya (Smythies)", "Forel coll.", "M.C.Z. Cotype No. 556" (originally labelled as *M. rugosa*; for details see Radchenko & Elmes, 2001) (MCZ);
Holotype of *M. everesti:* worker, "Himalaya, Jelap La, Tibetan side, 12,000 ft., l.iv.1924, Hingston" (BMNH);
Paratypes: 2 workers (BMNH), 1 worker "Himalaya, Jelap La, Tibetan side, 12,000 ft., l.iv.1924, Hingston" (ZMMU).
Distribution:
(a) India: ***Jammu & Kashmir:*** Sarthal 2390m (1), Pahalgam (2), Lidderwatt 2700m (2); ***Himachal Pradesh*****:** Badhal (Jubbal) 2090m (1), Sarthal 2050m (1), Bharmour 2400m (1), Old Manali 2231m (1), Solang 2640m (1), Koholaro 2210m (1), Sundli 2090m (1), Sarhan 2300m (1), Sarot (1), Giriganga Nr. Jubbal (1), Roggling 2720m (1), Kothi 2400m (1), vic. Kufri, 15km E Shimla 2500-2700m (2); ***Uttarakhand*****:** Mana 3200m (1), Auli 3000m (1), Chourangi Khaal 2300m (1), Chopta 2900m (1), Gobind Ghat 3000m (1) Ghanghria 3500m (1), Gangotri 3000m (1), Khara Pathhar 2700m (1), Khanag 2300m (1); ***West Bengal:*** Darjeeling (Sukhia 1880m (1), Tiger hills 2400m (1), Cheitry 2100m (1); ***Arunachal Pradesh:*** Bomdila 2940m (1), Jaswanthgarh 3146m (1); ***Sikkim:*** Phadamchen 1710m (1).
(b) Nepal: Luhme (2), Padmara-Khari Longa Bumra 2750-3400m (2), Thodung via Those 3100m (2), Phulchoki 2600m (2), Daman 2400m (2), Namsche Bazar 3450m (2), 18km NNE Baglung 2540m (2), 16 km SW Jomosom 2550m (2), 20km SSW Jomosom 2300m (2), W. Nepal, Sigarhi-Doti, Lokondo 2133m (2), Siklis 2133m (2), Gurjakhani 2591m (2), Tadopani, 3 km N Pakhar 2700m (2), Prov. Taplejung, Omje Kharka, NW Yamputh 2300-2500m (2), Namde-Jorsla 2890m (2).
(c) Bhutan: Sampa-Kotoka 2500m (2), 20km S Thimphu 2400m (2), Kotoka-Gogona 2600-3400m (2), Gogona 3100m (2), Dechli Paka 3300m (2), Bumthang (2), Thang-Rudungla 2400-3500m (2), Paesseling 3100-3400m (2), Batbalitang(Bumtang) 2600m (2).
Ecology: In the Northwest Himalaya, the species was collected under the stones in subtemperate forests of scattered *Cedrus,* oak and some broad-leaved trees. Few collection sites were under intense anthropogenic activities, surrounded by apple orchards. The mean temperature and humidity recorded at the nest was 31˚C and 63% respectively. The temperature ranges in summer (March to June) from 8˚C to 36˚C and during winter (November to February) from 3˚C to 27˚C. In Northeast Himalaya, nests were observed under stone in grasslands and on ground covered with dense vegetation, mostly in wet soil. Nesting sites had an average temperature of 15˚C and relative humidity of 85%. Alates were collected during the months of June to early August in Northwest Himalaya, and in September to October in Northeast Himalaya. Altitudinal range of this species varies from 1341m at the Ekra peak to 4084m in Central Himalaya.

Myrmica smythiesii Forel, 1902
= *Myrmica smythiesi* subsp. *himalayana* Weber, 1947, synonymy by Radchenko and Elmes, 2001
Lectotype of *M. smythiesii* (designated by Radchenko & Elmes, 2001): worker, "Himalaya (Smythies)", "*M. smythiesii* Forel", "LX/1, LX/12" (MHNG);
Paralectotypes (designated by Radchenko & Elmes, 2001): 2 workers "Himalaya (Smythies)", "*M. smythiesii* Forel", "LX/1, LX/12" ; 1 worker, "*M. smythiesi* Forel, Himalaya, 7000-12,000 ft (Smythies)", "M.C.Z type 20533" (MCZ); 2 workers (upper with gaster and waist stuck separately; bottom - without postpetiole and gaster), "*M. smythiesii* For. Himalaya" (MSNG);
Lectotype of *M. smythiesi* subsp. *himalayana* (designated by Radchenko & Elmes, 2001): worker, "India, Simla (Wroughton)" (MCZ);
Paralectotypes: (designated by Radchenko & Elmes, 2001): 2 workers "India, Simla (Wroughton)" (MCZ).
Distribution:
(a) India: ***Himachal Pradesh:*** Jachli 2400m (1), Pattidhank (25km above Jubbal) 2440m (1), Giriganga (28km from Jubbal) 2700m (1), Simla Hills, Kulala 2438m (2); ***Jammu & Kashmir:*** Tangmarg 2160m (1), Gulshan 3500m (1); ***Uttarakhand:*** Chopta, 2900m (1), Chakrata 2100m (1), Gobind Ghat to Ghanghria 3500m (1), Flower valley 3500m (1), Gangotri 2900m (1), Yangti, Almora 3749m (2).
(b) Nepal: Gompa, bei Tarahot 3400m (2).

Ecology: *Myrmica smythiesii* is distributed in forest composed of conifers (*Pinus*, *Cedrus*) and *Rhododendron* species at the subtemperate zone of Northwest Himalaya. The nests were located under stones and in rotten wood covered with leaves. The temperature and humidity recorded at the collection site were 25˚C and 67%, respectively, the nest temperature varied from 15˚C to 20˚C. Alates appear in the months of May, June and July. At few localities, *Myrmica smythiesii* is sympatric with *M. rugosa*. The altitudinal range for this species is 2133-3749m above mean sea level.

Myrmica tenuispina Ruzsky, 1905
Lectotype (designated by Radchenko & Elmes, 2001): worker (upper specimen on a pin with 4 workers), "Tabi-dara - Zagyrdesht, E. Bukhara, 17.vi.97, leg. Kaznakov" (original label in Russian), "*Myrmica rubra* L. r. *laevinodis* var. *tenuispina* Forel det, w, type" (ZMMU);
Paralectotypes (designated by Radchenko & Elmes, 2001): 3 workers on a pin with lectotype; 3 workers with the same labels (ZMMU); 8 workers with the same labels (ZISP); 1 worker with the same labels (MSNG); 2 workers, "Kala i Khont, Karategin, E Bukhara, leg. Kaznakov, 21.vi.97" (original label in Russian); "*Myrmica rubra* L. r. *laevinodis* var. *tenuispina* Forel det, w, type" (ZISP).
Distribution:
(a) Tadjikistan: Additional localities: Gissar range, Anzobsky pass, 2800m (2); Peter I range, Djirgital, 3000-3400m (3); Zeravshan Range, near Lake Iskanderkul; Zeravshan valley, Guldara, 2400m (3).
(b) Uzbekistan: Kashka-Daria Prov.: Ishkent; Khan-Talhta; 3300-3400m (3).
(c) Afghanistan: Badakshan, Sarekanda, 4100m (2).
Note: Previous records from Kyrgyzstan (Tarbinsky, 1976) and planes of Middle Asia (Dlussky et al., 1990) were based on misidentifications.
Ecology: *M. tenuispina* is associated with the mountains of Middle Asia and NE Afghanistan, and have been collected on subalpine meadows at altitudes between 2400 and 4100m above mean sea level and nests in the soil and under stones.

Myrmica urbanii Radchenko et Elmes 1998
Holotype: worker, "India, Shillong, Mawphlang, East Khasi, 3200ft, 2.05.86. leg. V. Darlong" (BMNH);
Paratypes: 86 workers from the same nest as holotype; 2 workers, "India, Mawphlang, Megalaya, 1850m, 15.05.1976, leg. Wittmer, Baroni Urbani"; 6 workers, "Upper Shillong, Megalaya, 1900m, 13.05.1976, leg. Wittmer, Baroni Urbani"; 3 workers, "Cherranukh, India, 1961, leg. Korovin" (BMNH, GEPC, NHMB, SIZK, ZMMU)
Distribution: **India:** Meghalaya (2).
Ecology: According to Radchenko and Elmes (2010), the ecology of this species is poorly known. It has been found at altitudes of 1000-1900m above mean sea level and one nest was found in soil beneath a log in a *Quercus* forest.

Myrmica varisculpta Radchenko et Rigato, 2009
Holotype: worker, **"**India, Kashmir, Leh, viii.1986 leg. C. Canepari" (MSNM)
Distribution: India: Kashmir (3).
Ecology: Unknown.

Myrmica villosa Radchenko et Elmes, 1999
Holotype: worker, "Dechli Paka, 5km O Pélela, 3300m, 19-20.06.1972 (Natural-History Museum Basel Bhutan Expedition, 1972)" (NHMB);
Paratypes: 15 workers, 1 queen with the same label (NHMB, BMNH, SIZK, GEPC).
Distribution: Bhutan (2).
Ecology: Virtually unknown, except that the type series were found at the altitude 3300m above mean sea level.

Myrmica vittata Radchenko *et* Elmes, 1999
Holotype: worker, "Pakistan, Bumburet, 24.05.1983, leg. M. Brancucci" (BMNH);
Paratypes: 2 workers, "Pakistan, Bumburet, 24.05.1983, leg. M. Brancucci"; 2 workers, "Pakistan, Kalam, 12.08.1994, leg. S. Dakatra" (BMNH, MSNM, SIZK, GEPC).
Distribution: Pakistan (2).
Ecology: Unknown.

Myrmica wardi Radchenko et Elmes, 1999
Holotype: worker, "Kashmir, Ladakh, Leh, 34°11'N, 77°35'E, 3450m, No.3094, 21.viii.1978 leg. P. Ward" (BMNH).
Paratypes: 6 workers with same label as holotype; 6 workers, 1 gyne, "Kashmir, Pahalgam, 34°02'N, 75°19'E, 2190m, No.3003, 27.07.1978"; about l00 workers, 2 males, "Kashmir, Lidderwat, 34°09'N, 75°l5'E, 2700 m, No.3015, 3018c, 3023, 3029, 30.07.1978"; 1 worker, l gyne, "Kashmir, Kulan, 34°l6'N, 75°09'E, 2100 m, No.3050-10, 3050-12, 08.08. l978"; 29 workers, 1 gyne, "Kashmir, Ladakh. Panikhar, Suru R., 34°07'N, 75°57'E, No.3077, 3078, 17.08.1978"; 3 workers, "Kashmir, Ladakh, Leh, 34°11'N, 77°35'E, 3450 m, No.3090, 21.08.l978"; 4 workers, "Kashmir, Sonamarg, 34°l8'N, 75°18'E, 2700 m, No.3102" (all leg. P.Ward); 8 workers, "Pakistan, Chitral Valley, between Dir and Lawari Pass, 2400 m, 11.08.1994, leg. S. Dacatra"; 3 workers, "Indien, Himachal Pradesh, vic. Theong, 25 km E Shimla, 2400 m, No 394, 29.09.1996, leg. A. Schulz and K. Vock"; 3 workers, 2 gynes, "India, Himachal Pradesh, Kullu valley, 5-7 km SW Rothang La Pass, 2500-2900 m, No. 432, 01.10.1996, leg. A. Schulz and K. Vock" (BMNH, NHMB, MSNM, ASPC, PSWC, SIZK, GEPC, MMPC).
Distribution:
(a) India: ***Jammu & Kashmir:*** Kongdoori 2880m (1), Seven Springs 3077m (1), Yusmarg 2380m (1), Patnitop 1973m (1), Gulmarg 2683m (1), Mughal garden 1670m (1), Pahalgham 2200m (1), Kongdoori 2880m (1); ***Himachal Pradesh*****:** Khinang Village 2940m (1), Solang 2573m (1), Gulaba 2700m (1), Keylong 2940m (1), Roggling 2740m (1), Nalivan (22km from Jubbal) 2300m (1), Prounthi 2260m (1), Sarthal 2200m (1),

Sarchu (1); ***Uttarakhand*:** Gangotri 2900m (1).

(b) Pakistan: Chitral Valley, between Dir and Lawari Pass, 2400m.

Ecology: According to the available information, *Myrmica wardi* was found in meadows with sparse willow trees, *Prunus, Acer* and fir species among woody shrubs with *Rosa* sp., and in stony grasslands. All recorded colonies were nesting in the soil. Most specimens were collected while foraging over low vegetation displaying the same behaviour of the European *Myrmica rubra*, which it could resemble in other habits (Radchenko & Elmes, 2010). However, according to the current information, this species was also collected at few places from open grasslands without any dense vegetation or forest cover, and the nests were not as deep as in *M. rubra*, the depth varied from 6-8 inches. Additionally, a couple of nests were found in shady places, where it was found to be sympatric with *Myrmica cachmiriensis*. The temperature of nesting site ranged from 15˚C to 25˚C and relative humidity from 39% to 69%. Alates were collected during the months of July and August. Altitudinal range for this species is 1670m-3450m above mean sea level.

Myrmica weberi Elmes et Radchenko, 2009

Holotype: worker, "NPL28 (No. 11- Elmes coll. label), Nepal, Sankhawalaya Maghang, Kharka, Makalu Barun Conservation Area, 27°36'18.5"N 87°7'30"E, 2634m, 7.xi.2005, leg. G. Alpert, Alonso and Subedi, CK-3, yak meadow under rocks, under stones" (MCZ).

Paratypes: 15 workers, 1 queen with the same label as holotype; 7 workers, "NPL25, Nepal, Sankhawalava Maghang, Kharka, Makalu Barun Conservation Area, 27°35'36.6"N 87°7'20.7"E, 2548 m, 5.xi.2005, leg. D.Emmett and Subedi, MK 21-283, Winkler trap"; 3 workers, "NPL 31, Nepal, Sankhawalava Makalu Barun Conservation Area, MK-4, 27° 35'24.8"N 87°7'18.7"E, 2563 m, 3.xi.2005, leg. G. Alpert, on rock under moss, large colony with 2q"; 3 workers "NPL 32, Nepal, Sankhawalava Makalu Barun Conservation Area, MK-6, 27°35'24.8"N 87°7'18.7"E, 2563 m, 3.xi.2005, leg. G. Alpert, open meadows under logs"; 7 workers "NPL 33, Nepal, Sankhawalava, Makalu Barun Conservation Area, MK W17, 7.xi.05, Winkler trap"; 1 worker, "India, Darjeeling Distr., Tiger Hill, 2500 m, 27.v.1975, leg. W. Wittmer", "*M.indica* Weber det. Radchenko and Elmes"; 1 worker, "Kosi, Chauki, 2°11-12'N 87°27-28'E 2000-3000 m, 22-24.vi.01, NHMB Expd. Npl. 2001"; 1 worker, "Bhutan, Nolding, 41km O Wangdi, 2800 m, Nat. Hist. Museum Basel- Bhutan Expedition, 1972", "*M. indica* Weber det Radchenko and Elmes"; 1 worker, "NPL2.1, Nepal, Rigmo, H.Tabata, 7.vi.1978", *"M. indica* Weber det Radchenko and Elmes"(NHMB, SIZK, GEPC, MCZ).

Distribution:

(a) India: West Bengal (3).

(b) Nepal (3).

(c) Bhutan: Sampa-Kotoka, 1400-2600m (3).

Ecology: This species is probably restricted to the Southern slopes of the Central Himalaya (Nepal, India and Bhutan), where it lives between 2000 and 3000m. The collection data suggests that *Myrmica weberi* might be a rather reclusive species that nests under moss, dead wood and rocks, mostly foraging close to the ground and litter (Radchenko & Elmes, 2010).

Myrmica williamsi Radchenko et Elmes, 1999

Holotype: worker, "India, Kashmir, Pantitop, 2000m, 6.09.86, leg. P. Williams" (BMNH).

Distribution: India: *Jammu and Kashmir*: Seven Springs 30 77m (1); ***Uttarakhand*:** Ghangria 3500m (1), Chopta 2900m (1).

Ecology: the nests were found under stones in open meadows of mountain slopes. Temperature and humidity of the collection site ranged from 19-23˚C and 63-75%. Altitudinal range of this species varies from 2000m to 3500m above mean sea level.

Myrmica wittmeri Radchenko *et* Elmes, 1999

Holotype: worker, "Indien, Him. Prad. [Himahal Pradesh], Mahri, 3000–3200 m, 15.05.1977, leg. Wittmer et Brancucci" (NHMB).

Paratypes: 3 workers (one missing head), "Indien, Him. Prad. [Himahal Pradesh], Mahri, 3000–3200 m, 15.05.1977, leg. Wittmer et Brancucci" ; 6 workers, "India**,** Himachal Pradesh, Kullu valley, La Pass, 3400-3700m, 2.10.1996, No.420, 422. leg. A.Schulz & K.Vock"; 3workers, "Pakistan, Kalam, 2300m, 12.07.1994. leg. S. Dakatra" (NHMB, IZK, MSNM, ASPC, GEPC).

Distribution:

(a) India: *Uttarakhand*: Chopta 2900m (1), Gangotri 2900m (1), Kedarnath 3300m (1); ***Himachal Pradesh:*** Marhi 3090-3160m (1, 2), Rekongpeo 2600m (1).

(b) Pakistan: Kalam, 2300m.

Ecology: *Myrmica wittmeri* seems to be well adapted to high altitude regions of Himalaya above the timberline. The nests were observed under stone and in rotten wood, in ground covered with scarce vegetation mainly of *Rhododendron*. Nest temperature ranged from 15˚C to 23˚C and relative humidity varied from 43% to 72%. Alates appear in the month of June and July. Altitudinal range of this species is 2300m to 3300m.

Conclusion

Extending nearly 3000km from the east to west, the Himalayan mountain range consists of complex topographical features, varied climate, which differs profoundly in the extreme eastern and western ends of Himalaya and thus supports remarkable assemblage of vegetation types (Mani, 1968, 1974; Bharti, 2008). The dry climatic conditions of Northwest have favoured the penetration of Middle Asian floral elements currently represented by species of *Juniperus*, *Artemisia*, *Eremurus*, *Ferula, Cedrus*, etc. Additionally, the moist climatic conditions of eastern region of Himalaya has favoured the influx of elements originating from western China extending from Yunnan, which include *Primula, Magnolia*

etc., with lineages of *Circaester agretis* extending from China across Tibet to Himalaya. Thus, the distributional patterns of present day plants in Himalaya clearly indicate that the plants of eastern region show affinities with flora of Western and Northwestern China and of western region with flora of Western, Middle and North Asian mountains (Mani, 1974). However, there are few other plant species, which have extended distribution along the entire stretch of Himalaya after their penetration either from east or west. Based on the evidence generated by phyto-geographical affinities of Himalayan elements, Hooker (1906) and Stearn (1960) consider 80° to 84° EL (west of Nepal) as a transitional zone "where climatic factors presumably limit the capacity of the plants suited to one provenance to compete with those of the other" (Stearn, 1960). Consequently, the west and Middle Asian mountain plant species adapted to comparatively dry conditions extend along the Himalayan mountain chain from Afghanistan to west Nepal, whereas species originating from the moist regions of mountains of China extend as far as far west in eastern Kumaon bordering Nepal (Stearn, 1960; Rau, 1974). Furthermore, the historical and geological facts also suggest that Himalaya has served as primarily as a 'route of emigration and colonization from east and northwest, secondarily of endemic development' (Stearn, 1960; Rau, 1974). Similar sort of distributional pattern has been noticed in some of the vertebrates and invertebrates (Mani, 1974), however such cases have not been well documented. In any instance, the evolution of Himalayan flora and fauna is of considerable significance, as the adjoining mountain regions of China, Tibet and Middle Asia, which are much older in age as compared to Himalaya, have considerable influence on Himalayan life. Later, in Pleistocene, the changes in topography and climate of Himalaya impacted by intermittent glacial and interglacial periods followed by Post-Pleistocene uplift might have influenced the animal and plant life (Mani, 1974). A direct consequence of that glacial period was extinctions, survival of relic forms, migrations, formation of new refugia, exchange of elements, speciation etc., hence accounting for present day diversity, endemism and biogeographical affinities with adjoining regions. In accordance with the distributional data presented in the preceding text, *Myrmica* lineages in Himalaya depict a pattern quite similar to the other life forms occurring in Himalaya. Likewise, some of the *Myrmica* species are restricted to Northwestern ranges, some to Northeastern region of Indian Himalaya, while few others have wider distribution extending throughout the Himalayan range. These lineages are distributed within an altitudinal range of 1000-4800m (Table 1), but the majority are restricted to the temperate zone. *M. afghanica*, *M. tenuispina*, *M. rigatoi*, *M. pseudorugosa* and *M. vittata* are restricted to Northeastern Afghanistan and Pakistan, while *M. cachmiriensis*, *M. ordinaria*, *M. wardi* and *M. wittmeri* extend from Northeastern Pakistan to Northwestern part of Indian Himalaya. Nineteen of the species (*M. adrijae*, *M. curvispinosa*, *M. elmesi*, *M. ereptrix*,

Table 1. List of *Myrmica* species with their altitudinal range.

	Species	Altitudinal Range
1	*Myrmica adrijae* Bharti, 2012	2479m
2	*Myrmica afghanica* Radchenko et Elmes, 2003	3660m (approx.)
3	*Myrmica aimonissabaudiae* Menozzi, 1939	1300 - 3500m
4	*Myrmica alperti* Elmes et Radchenko, 2009	2200 - 3200m
5	*Myrmica boltoni* Radchenko et Elmes, 1998	2000 - 3400m
6	*Myrmica brancuccii* Radchenko, Elmes et Collingwood, 1999	2400m
7	*Myrmica cachmiriensis* Forel, 1904	1829 - 3500m
8	*Myrmica collingwoodi* Radchenko et Elmes, 1998	2450 - 3100m
9	*Myrmica curvispinosa* Bharti et Sharma, 2013	2479 - 2700m
10	*Myrmica elmesi* Bharti et Sharma, 2011	2000 - 2200m
11	*Myrmica ereptrix* Bolton, 1988	2800m
12	*Myrmica foreliana* Radchenko et Elmes, 2001	2900m
13	*Myrmica fortior* Forel, 1904	1981 - 2700m
14	*Myrmica hecate* Weber, 1947	1300 - 3700m
15	*Myrmica indica* Weber, 1950	1400 - 3150m
16	*Myrmica inezae* Forel, 1902	1900 - 3000m
17	*Myrmica kothiensis* Bharti et Sharma, 2013	2479m
18	*Myrmica kozlovi* Ruzsky, 1915	2743 - 4800m
19	*Myrmica latra* Bharti, Radchenko et Sasi, 2016	2260 - 2740m
20	*Myrmica longisculpta* Bharti et Sharma, 2011	2000 - 3100m
21	*Myrmica martensi* Radchenko *et* Elmes, 1998	3200m
22	*Myrmica nefaria* Bharti, 2012	2469m
23	*Myrmica nitida* Radchenko et Elmes, 1999	2600 - 3600m
24	*Myrmica ordinaria* Radchenko et Elmes, 1999	2300 - 3077m
25	*Myrmica pachei* Forel, 1906	2600 - 3600m
26	*Myrmica petita* Radchenko et Elmes, 1999	2300 - 2400m
27	*Myrmica pseudorugosa* Bharti, 2012	3600m
28	*Myrmica radchenkoi* Bharti et Sharma, 2011	2000m
29	*Myrmica religiosa* Bharti et Sharma, 2013	2300m
30	*Myrmica rhytida* Radchenko et Elmes, 1999	2800 - 4200m
31	*Myrmica rigatoi* Radchenko et Elmes, 1998	2200 - 2300m
32	*Myrmica rugosa* Mayr, 1865	1400 - 3500m
33	*Myrmica rupestris* Forel, 1902	1341 - 4084m
34	*Myrmica smythiesii* Forel, 1902	2133 - 3749m
35	*Myrmica tenuispina* Ruzsky, 1905	2400 - 4100m
36	*Myrmica urbanii* Radchenko et Elmes, 1998	975 - 1900m
37	*Myrmica varisculpta* Radchenko et Rigato, 2009	3350m
38	*Myrmica villosa* Radchenko et Elmes, 1999	3300m
39	*Myrmica vittata* Radchenko et Elmes, 1999	1690 - 3784m (approx.)
40	*Myrmica wardi* Radchenko et Elmes,1999	1670 - 3450m
41	*Myrmica weberi* Elmes et Radchenko, 2009	1400 -3000m
42	*Myrmica williamsi* Radchenko et Elmes, 1999	2000 -3500m
43	*Myrmica wittmeri* Radchenko et Elmes, 1999	2300 - 3300m

Table 2. Known species diversity of genus *Myrmica* in each state/country.

Species name/Locality	*JK*	*HP*	*UK*	*AP*	*WB*	*MH*	*SK*	*NP*	*BT*	*PK*	*AF*
Myrmica adrijae Bharti, 2012		+									
Myrmica afghanica Radchenko et Elmes, 2003											+
Myrmica aimonissabaudiae Menozzi, 1939	+	+	+	+	+	+	+	+	+	+	+
Myrmica alperti Elmes et Radchenko, 2009								+			
Myrmica boltoni Radchenko et Elmes, 1998								+			
Myrmica brancuccii Radchenko, Elmes et Collingwood, 1999								+		+	
Myrmica cachmiriensis Forel, 1904	+	+								+	
Myrmica collingwoodi Radchenko et Elmes, 1998									+		
Myrmica curvispinosa Bharti et Sharma, 2013		+									
Myrmica elmesi Bharti et Sharma, 2011	+										
Myrmica ereptrix Bolton, 1988	+										
Myrmica foreliana Radchenko et Elmes, 2001			+								
Myrmica fortior Forel, 1904	+										
Myrmica hecate Weber, 1947	+	+	+	+	+		+	+			
Myrmica indica Weber, 1950				+	+			+	+		
Myrmica inezae Forel, 1902		+	+								
Myrmica kothiensis Bharti et Sharma, 2013		+									
Myrmica kozlovi Ruzsky, 1915				+	+		+				
Myrmica latra Bharti, Radchenko et Sasi, 2016		+									
Myrmica longisculpta Bharti et Sharma, 2011	+										
Myrmica martensi Radchenko *et* Elmes, 1998								+			
Myrmica nefaria Bharti, 2012		+									
Myrmica nitida Radchenko et Elmes, 1999	+	+									
Myrmica ordinaria Radchenko et Elmes, 1999	+									+	
Myrmica pachei Forel, 1906				+				+	+		
Myrmica petita Radchenko et Elmes, 1999	+										
Myrmica pseudorugosa Bharti, 2012										+	
Myrmica radchenkoi Bharti et Sharma, 2011	+										
Myrmica religiosa Bharti et Sharma, 2013			+								
Myrmica rhytida Radchenko et Elmes, 1999	+	+									
Myrmica rigatoi Radchenko et Elmes, 1998										+	
Myrmica rugosa Mayr, 1865	+		+		+			+	+		
Myrmica rupestris Forel, 1902	+	+	+	+	+		+	+	+		
Myrmica smythiesii Forel, 1902	+	+	+					+			
Myrmica tenuispina Ruzsky, 1905											+
Myrmica urbanii Radchenko et Elmes, 1998						+					
Myrmica varisculpta Radchenko et Rigato, 2009	+										
Myrmica villosa Radchenko et Elmes, 1999									+		
Myrmica vittata Radchenko et Elmes, 1999										+	
Myrmica wardi Radchenko et Elmes,1999	+	+	+							+	
Myrmica weberi Elmes et Radchenko, 2009					+			+	+		
Myrmica williamsi Radchenko et Elmes, 1999	+		+								
Myrmica wittmeri Radchenko et Elmes, 1999		+	+								
No. of species	**18**	**15**	**11**	**6**	**7**	**2**	**4**	**12**	**8**	**9**	**3**

*JK- Jammu & Kashmir; HP- Himachal Pradesh; UK- Uttarakhand; AP- Arunachal Pradesh; WB- West Bengal; MH- Meghalaya; SK- Sikkim; NP- Nepal; BT- Bhutan; PK- Pakistan; AF- Afghanistan

M. foreliana, *M. fortior*, *M. inezae*, *M. kothiensis*, *M. latra*, *M. longisculpta*, *M. nefaria*, *M. nitida*, *M. petita*, *M. radchenkoi*, *M. religiosa*, *M. rhytida*, *M. smythiesii*, *M. varisculpta* and *M. williamsi*) are exclusively restricted to Northwestern region of Indian Himalaya and do not extend much further; whereas some of the species (*M. alperti*, *M. boltoni*, *M. martensi*) are concentrated in Central Himalaya (Nepal). Similarly, *M. collingwoodi* and *M. villosa* are only restricted to Bhutan. On contrary, *M.urbanii, M. weberi*, *M. indica*, *M. kozlovi* and *M. pachei* seem to have penetrated from Northeastern region of Himalaya and extend up to Central Himalaya and are not recorded hitherto from Northwestern region. Besides, *M. aimonissabaudiae*, *M. rugosa*, *M. hecate*, *M. rupestris* have wider distribution and extend throughout the Himalayan range.

Based on the similarity of certain peculiar morphological features, Radchenko and Elmes (2010) have clustered Himalayan *Myrmica* species in to various species groups; *inezae* species group includes *M. inezae*, *M. radchenkoi*, *M. kothiensis*, *M. religiosa*, *M. curvispinosa* and *M. rigatoi* and this species group is exclusively restricted to Northwestern and Central Himalaya and does not penetrate into Northeastern Himalaya. The same pattern has been observed in the case of *rugosa* species group (*M. longisculpta*, *M. cachmiriensis*, *M. ordinaria*, *M. wardi*, *M. foreliana*, *M. afghanica*, *M. pseudorugosa*) with the exclusion of *M. aimonissabaudiae*, *M. rugosa*, *M. rupestris*, *M. hecate* having wider distribution. A similar case is present by the *smythiesii* species group (*M. smythiesii*, *M. adrijae*, *M. fortior, M. wittmeri*, *M. nefaria*, *M. ereptrix* and *M. latra*) and few other species *M. nitida, M. petita*, *M. rhytida*, *M. williamsi*, which have not been placed in any of the species groups. *Ritae* species group (*M. alperti, M. boltoni, M. collingwoodi, M.indica, M.martensi, M.urbanii* and *M.weberi*) and *pachei* species group (*M. pachei* and *M.villosa*) are restricted to Northeastern and Central Himalaya.

From the foregoing discussion, it seems quite probable that some of the ancestral lineages of *rugosa* species group after penetration from north in Himalaya got isolated from rest of *Myrmica* fauna, speciated and spread from Northwest Himalaya up to Central Himalaya (with exception of *M. aimonissabaudiae*, *M. rugosa*, *M. rupestris* and *M. hecate,* which extend throughout the Himalayan range). Almost similar is the distributional pattern of species belonging to *inezae and smythiesii* species groups with none of the species belonging to this group has penetration beyond Central Himalaya. On contrary, it seems quite logical that the other lineages currently represented by species of *pachei* and *ritae* species groups infiltrated from Western China and diversified in Himalaya, and spread from Northeast Himalaya up to Central Himalaya. This west-east, east-west spreading of lineages in Himalaya is even validated by the absence of species belonging to *rugosa* species group in mountains of China, and by the presence of species belonging to *ritae* and *pachei* species groups in China and Northeastern Himalaya (as 50% of *Myrmica* fauna occurring in mountains of China is represented by species belonging to *ritae* and *pachei* species groups).

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