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# Three new species of genus *Myrmica* (Hymenoptera: Formicidae) from Himalaya

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ABSTRACT

Three new species of the genus *Myrmica* are described from the Himalayas. *Myrmica curvispinosa* sp. nov., *Myrmica kothiensis* sp. nov. and *Myrmica religiosa* sp. nov. belong to the *Myrmica inezae* species group, which is earlier represented by 4 species. *Myrmica curvispinosa* sp. nov. is described based on worker and gyne, with a report of ergatoid as well. *Myrmica kothiensis* sp. nov. and *Myrmica religiosa* sp. nov. are described based on worker caste only. A key to the species of the *Myrmica inezae* species group has been provided in the following.


## Introduction

The ant genus *Myrmica* Latreille comprises 148 valid species in the Old world (Radchenko and Elmes, 2010; Bharti and Sharma, 2011a,b,c; Bharti, 2012a,b), which are widely distributed in the Palaearctic and South-East Asian tropical and subtropical regions. The *Myrmica* fauna of the Central Asian mountains, which comprise the Hindu Kush, Karakorum, and south-western slope of the Himalayas (Afghanistan, Pakistan, India, Nepal and Bhutan), contains 36 species representing 7 species groups; 34 species (94.44%) are endemic to this region. Although the species groups in *Myrmica* as proposed by Radchenko and Elmes (2001, 2010) are based on arbitrary morphological divisions, most appear to be monophyletic and seem to have some phylogenetic value as verified by molecular studies (Jansen et al., 2009, 2010).

*Myrmica curvispinosa* sp. nov., *Myrmica kothiensis* sp. nov. and *Myrmica religiosa* sp. nov. belong to the *inezae* species group. The *Myrmica inezae* species group, which is currently represented by 4 species (*M. inezae* Forel, *M. rigatoi* Radchenko et Elmes, *M. mixta* Radchenko et Elmes and *M. radchenkoi* Bharti et Sharma), is distributed in the Himalayas and south-western China. The female castes of this group share many features with the *ritae* species group, but well differ from the latter by a strongly prominent and non-notched anterior clypeal margin. This group is characterized by the long scape that is smoothly curved at the base, non-angled and without any trace of a lobe or carina; frontal carinae are slightly curved, frons wide and frontal lobes are not extended. Petiole has very long and thin peduncle, postpetiole subglobular. Propodeal spines are very long, and propodeal lobes are rounded (Radchenko and Elmes, 2010).

With the discovery of three new species, it seems that the *inezae* species group is quite diverse in the Himalayas. As suggested by Radchenko and Elmes (2010), the *inezae* species group represents a relict of old fauna closely related to the *ritae* and *rugosa* species group lineages because differences in their morphology do not suggest any dramatic adaptive morphological reorganization. Probably, the upliftment of the Himalayas as an isolation barrier has led to the diversification of *Myrmica* fauna in the region.

## Materials and methods

The specimens were preserved in 70% alcohol. The mounted material was analyzed using a Nikon SMZ-1500 stereo zoom microscope. For digital images, an MP evolution digital camera was used on the same microscope with Auto-Montage (Syncroscopy, Division of Synoptics, Ltd.) software. Later, images were cleaned using Helicon Filter 5 software. For morphological measurements (all in mm) Radchenko and Elmes (2010) have been followed. In addition, gastral length (GL) and gastral width (GW) has been measured to compare the ergatoid with workers.

HL maximum length of the head in dorsal view, measured in a straight line from the anterior point of the clypeus (including any carina or ruga, if they protrude beyond the anterior margin) to the mid-point of the occipital margin.

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HW maximum width of the head in dorsal view behind the eyes.
FW minimum width of the frons between the frontal carinae.
FLW maximum distance between the outer borders of the frontal lobes.
SL maximum straight-line length of the scape from its apex to the articulation with condylar bulb.
AL diagonal length of the mesosoma seen in profile, from the anterior end of the neck shield to the posterior margin of propodeal lobes.
PL maximum length of petiole from above/in dorsal view, measured from the posterodorsal margin of the petiole to the articulation with propodeum, the petiole should be positioned so that measured points lay on the same plane.
PPL maximum length of the post-petiole in dorsal view between its visible anterior and posterior margins.
PW maximum width of the petiole in dorsal view.
PPW maximum width of the postpetiole from above/in its dorsal view.
PH maximum height of the petiole in profile, measured from the uppermost point of the petiolar node perpendicularly to the imaginary line between the anteroventral (just behind the subpetiolar process) and posteroventral points of the petiole.
PPH maximum height of the postpetiole in profile from the uppermost to the lowermost point, measured perpendicularly to the tergo-sternal suture.
ESL maximum length of the propodeal spine in profile, measured along the spine from its tip to the deepest point of the propodeal constriction at the base of the spine.
ESD distance between the tips of propodeal spines in dorsal view.
PNW maximum width of the pronotum in dorsal view.
TL total length.

Indices used:

| | |
|---|---|
| Cephalic | CI = HL/HW |
| Frontal | FI = FW/HW |
| Frontal lobe | FLI = FLW/FW |
| Scape − 1 | $SI_1$ = SL/HL |
| Scape − 2 | $SI_2$ = SL/HW |
| Petiolar − 1 | $PI_1$ = PL/PH |
| Petiolar − 2 | $PI_2$ = PL/HW |
| Petiolar − 3 | $PI_3$ = PW/HW |
| Post-petiolar − 1 | $PPI_1$ = PPL/PPH |
| Post-petiolar − 2 | $PPI_2$ = PPH/PPW |
| Post-petiolar − 3 | $PPI_3$ = PPW/PW |
| Post-petiolar − 4 | $PPI_4$ = PPW/HW |
| Propodeal spine length | ESLI = ESL/HW |
| Propodeal spine width | ESDI = ESD/ESL |

Map showing the different localities of the *Myrmica inezae* species.

*Acronyms of depositories*

BMNH: The Natural History Museum, London (= British Museum Natural History), U.K.

PUAC: Punjabi University Patiala, Ant Collection at Department of Zoology and Environmental Sciences, Punjabi University, Patiala, Punjab, India.

## Taxonomy

*Myrmica curvispinosa* Bharti et Sharma sp. nov.

*Material examined*. Holotype Worker, India, Himachal Pardesh, Shoja, 31.568069°N, 77.372096°E, 2700 m, 10.ix.2008; Paratypes: 85 workers and 2 gynes from the nest of holotype; 1 worker and 1 ergatoid, India, Himachal Pardesh, Kothi, 32.319325°N, 77.197945°E, 2479 m, 16.vi.2003. All specimens are in PUAC (DST 358/296). Two paratypes will be deposited in BMNH.

*Description*. Worker (Figs. 1–3, Table 1). Head longer than wide, sides slightly convex, occipital corners evenly rounded; mandibles with 9 teeth (apical and preapical ones are the largest), longitudinally rugulose without punctures; clypeus convex, pointed anteriorly, longitudinally rugose, surface between rugae smooth and shiny; frontal triangle polished, smooth and shiny; frontal lobes narrow, frontal carinae merge with the rugae that surround the antennal sockets, anterior half of the frons with longitudinal rugae, less than 15 rugae between frontal carinae at the level of eyes, remaining part of head dorsum reticulate, surface between rugae appears shiny; antennae 12 segmented with 4 segmented club, scape feebly curved at the base, without any trace of lobe or carina, longitudinally rugulose, punctulate, ¼$^{th}$ longer than head length.

Mesosoma forming a regular arch in profile, pronotal dorsum coarsely reticulate with few transverse rugae, promesonotal suture indistinct; mesonotum with coarse transverse rugae; metanotal groove smooth, few longitudinal rugulae on sides of metanotal groove; propodeal dorsum with coarse transverse rugae, propodeal spines long, pointed, directed backward, tips weakly curved upward, propodeal lobes rounded, propodeal declivity smooth and shiny; sides of pronotum reticulate, rest of the mesosoma longitudinally rugose without punctures, rugae on sides of mesosoma merge with transverse rugae on propodeal dorsum; petiole with long peduncle ($PI_1$ 1.71) and well developed sub-petiolar process, petiolar dorsum reticulate-rugulose, sides reticulate; postpetiole sub-globular, little longer than wide, dorsum smooth and shiny, sides rugulose. Gaster smooth and shiny.

Short sub-decumbent hairs present on head, more dense on sides. Long erect hairs on head dorsum including clypeus, mesosoma, petiole, postpetiole and gaster. Short suberect hairs also present on gaster. Head, mesosoma, petiole, postpetiole and gaster brownish-black; mandibles, antennae and legs reddish-brown.

*Gyne* (Figs. 4–6, Table 1). Similar to worker except pronotal dorsum transversally rugose, reticulate on sides, rest of the mesosoma longitudinally rugose; scutum and scutellum shiny, costate, without punctures; transverse rugulosity encircles scutellum posteriorly, sclerite between scutellum and propodeum transversally rugulose; propodeum with divergent rugae, propodeal spines shorter, surface between spines transversally regulate; declivity smooth and shiny; propodeal lobes rounded.

*Ergatoid* (Figs. 7–9, Table 1). Similar to worker except the posterior part of the clypeus is much more convex, propodeal spines thick, gaster exceptionally long and wide as compared to workers. Short depressed hairs on head and mesosoma, long scattered hairs on head, petiole, postpetiole and gaster.

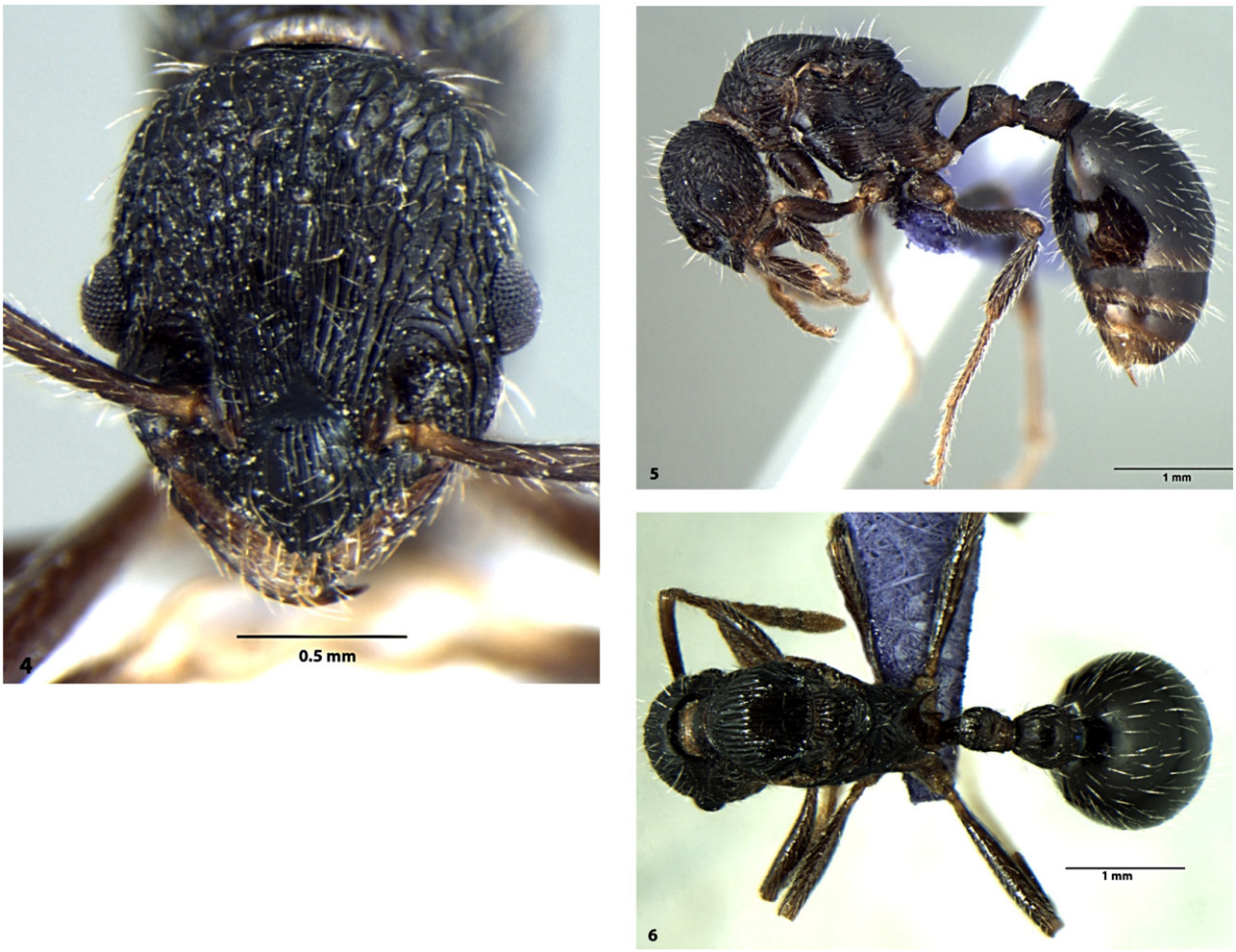
Males unknown.

*Differential diagnosis*. *Myrmica curvispinosa* sp. nov. belongs to the *Myrmica inezae* species group due to a very long petiole ($PI_1$ 1.71), shape and length of spine and sculpture of mesosoma dorsum. It well differs from other species of this group, *M. rigatoi* and *M. radchenkoi* by comparatively much shorter propodeal spines (ESLI 0.35, whereas in *M. rigatoi* and *M. radchenkoi* ESLI 0.52 and 0.42, respectively). However, due to some transverse rugosity on mesosoma it is somewhat similar to *M. inezae*, but differs considerably from it by the following combination of characters: in *M. inezae* whole mesosoma dorsum, the petiole and postpetiole have coarse transversal rugosity and propodeal spines are much longer (ESLI 0.42), whereas in *M. curvispinosa* sp. nov. pronotum reticulate, mesopropodeum transverse, and petiole reticulate-rugulose, the postpetiole is smooth and shiny and propodeal spines are much shorter (ESLI 0.28–0.35). Moreover, both species show significant differences in the morphology of gyne as well. In *M. curvispinosa* sp. nov. the scutum is separated from the scutellum by a convex ridge, propodeal spines are comparatively short, and the


**Figs. 1–3.** *Myrmica curvispinosa* sp.nov., (Worker) 1. Head in full-face view; 2. body, lateral view; 3. body, dorsal view.

**Table 1**
The mean, standard deviation, minimum and maximum values (in mm) of the measurements and indices of *M. curvispinosa* sp. nov.

| | | Holotype | Workers (21) | | | Queens (2) | Ergatoid (1) |
|---|---|---|---|---|---|---|---|
| | | | Mean ± SD | Min | Max | Mean ± SD | |
| Measurements | FLW | 0.43 | 0.43 ± 0.01 | 0.42 | 0.45 | 0.48 ± 0.01 | 0.42 |
| | FW | 0.41 | 0.41 ± 0.01 | 0.40 | 0.42 | 0.45 ± 0.00 | 0.38 |
| | HL | 1.22 | 1.17 ± 0.02 | 1.15 | 1.22 | 1.22 ± 0.00 | 1.16 |
| | PL | 0.60 | 0.59 ± 0.01 | 0.57 | 0.61 | 0.72 ± 0.03 | 0.62 |
| | PH | 0.35 | 0.35 ± 0.01 | 0.34 | 0.36 | 0.42 ± 0.00 | 0.38 |
| | ESL | 0.32 | 0.30 ± 0.02 | 0.25 | 0.31 | 0.30 ± 0.02 | 0.3 |
| | HW | 0.92 | 0.91 ± 0.02 | 0.88 | 0.95 | 1.00 ± 0.01 | 0.92 |
| | SL | 1.06 | 1.04 ± 0.02 | 1.01 | 1.06 | 1.09 ± 0.01 | 1.10 |
| | PPH | 0.39 | 0.38 ± 0.01 | 0.37 | 0.40 | 0.45 ± 0.02 | 0.31 |
| | PW | 0.29 | 0.29 ± 0.01 | 0.27 | 0.30 | 0.36 ± 0.01 | 0.32 |
| | PPW | 0.41 | 0.41 ± 0.02 | 0.39 | 0.44 | 0.50 ± 0.01 | 0.49 |
| | PPL | 0.43 | 0.40 ± 0.02 | 0.37 | 0.43 | 0.48 ± 0.03 | 0.43 |
| | PNW | 0.68 | 0.67 ± 0.02 | 0.65 | 0.69 | – | 0.71 |
| | ESD | 0.43 | 0.44 ± 0.03 | 0.39 | 0.50 | 0.55 ± 0.01 | 0.43 |
| | AL | 1.71 | 1.68 ± 0.05 | 1.58 | 1.76 | 2.09 ± 0.04 | 1.69 |
| | AH | 0.72 | 0.70 ± 0.01 | 0.68 | 0.72 | 1.20 ± 0.02 | 0.71 |
| | SCL | – | – | – | – | 0.98 ± 0.01 | – |
| | SCW | – | – | – | – | 1.36 ± 0.06 | – |
| | GL | 1.84 | 1.82 ± 0.12 | 1.33 | 1.84 | 2.15 ± 0.06 | 2.62 |
| | GW | 1.06 | 1.05 ± 0.04 | – | – | – | 1.64 |
| | TL | 5.80 | 1.57 ± 0.16 | – | – | 6.63 | 6.52 |
| Indices | FI | 0.45 | 0.45 ± 0.01 | 0.43 | 0.47 | 0.45 ± 0.01 | 0.41 |
| | CI | 1.33 | 1.29 ± 0.02 | 1.24 | 1.33 | 1.22 ± 0.02 | 1.26 |
| | $SI_1$ | 0.87 | 0.89 ± 0.01 | 0.87 | 0.91 | 0.89 ± 0.01 | 0.95 |
| | $SI_2$ | 1.15 | 1.15 ± 0.02 | 1.12 | 1.18 | 1.09 ± 0.00 | 1.20 |
| | FLI | 1.05 | 1.05 ± 1.26 | 1.05 | 1.08 | 1.06 ± 0.02 | 1.11 |
| | $PI_1$ | 1.71 | 1.71 ± 0.05 | 1.63 | 1.76 | 1.71 ± 0.07 | 1.63 |
| | $PI_2$ | 0.65 | 0.65 ± 0.01 | 0.63 | 0.67 | 0.72 ± 0.04 | 0.67 |
| | $PI_3$ | 0.32 | 0.32 ± 0.01 | 0.30 | 0.33 | 0.36 ± 0.01 | 0.35 |
| | $PPI_1$ | 1.10 | 1.05 ± 0.06 | 0.97 | 1.08 | 1.08 ± 0.12 | 1.39 |
| | $PPI_2$ | 0.95 | 0.93 ± 0.02 | 0.90 | 0.95 | 0.90 ± 0.03 | 0.63 |
| | $PPI_3$ | 1.41 | 1.44 ± 0.05 | 1.39 | 1.52 | 1.39 ± 0.05 | 1.53 |
| | $PPI_4$ | 0.45 | 0.45 ± 0.01 | 0.44 | 0.47 | 0.44 ± 0.01 | 0.53 |
| | ESLI | 0.35 | 0.33 ± 0.02 | 0.28 | 0.35 | 0.29 ± 0.02 | 0.33 |
| | ESDI | 1.34 | 1.50 ± 0.11 | 1.37 | 1.67 | 1.85 ± 0.16 | 1.43 |




**Figs. 4–6.** *Myrmica curvispinosa* sp. nov., (Gyne) 4. Head in full-face view; 5. body, lateral view; 6. body, dorsal view.

petiole has a very long peduncle (ESLI 0.29, $PI_1$ 1.71). Whereas in *M. inezae* a concave ridge separates the scutum from the scutellum, propodeal spines are much longer, and the petiole has a shorter penduncle (ESLI 0.41, $PI_1$ 1.63).

*Etymology*. The species is named after the shape of propodeal spines, which are curved at the tips.

*Ecology*. *Myrmica curvispinosa* sp. nov. has been collected by the hand picking method from a nest under stones in a patchy *Cedrus* forest in a temperate region of the Himalayas. The forest was surrounded by cultivated fields and an apple orchard. The temperature recorded at the site was 23 °C. One paratype and ergatoid were collected from another locality (Kothi), beneath a stone in moist soil. The area was surrounded by a patchy *Cedrus* forest with grass cover and located under the foothills of Peer-Panjal range of the Himalayas, covered with snow from October to mid-March.

*Myrmica kothiensis* Bharti et Sharma sp. nov.

*Material examined*. Holotype Worker, India, Himachal Pardesh, Kothi, 32.319325°N, 77.197945°E, 2479 m, 16.vi.2003; paratypes, 3 workers from the nest of holotype. All specimens are in PUAC (No. 193). One paratype will be deposited in BMNH.

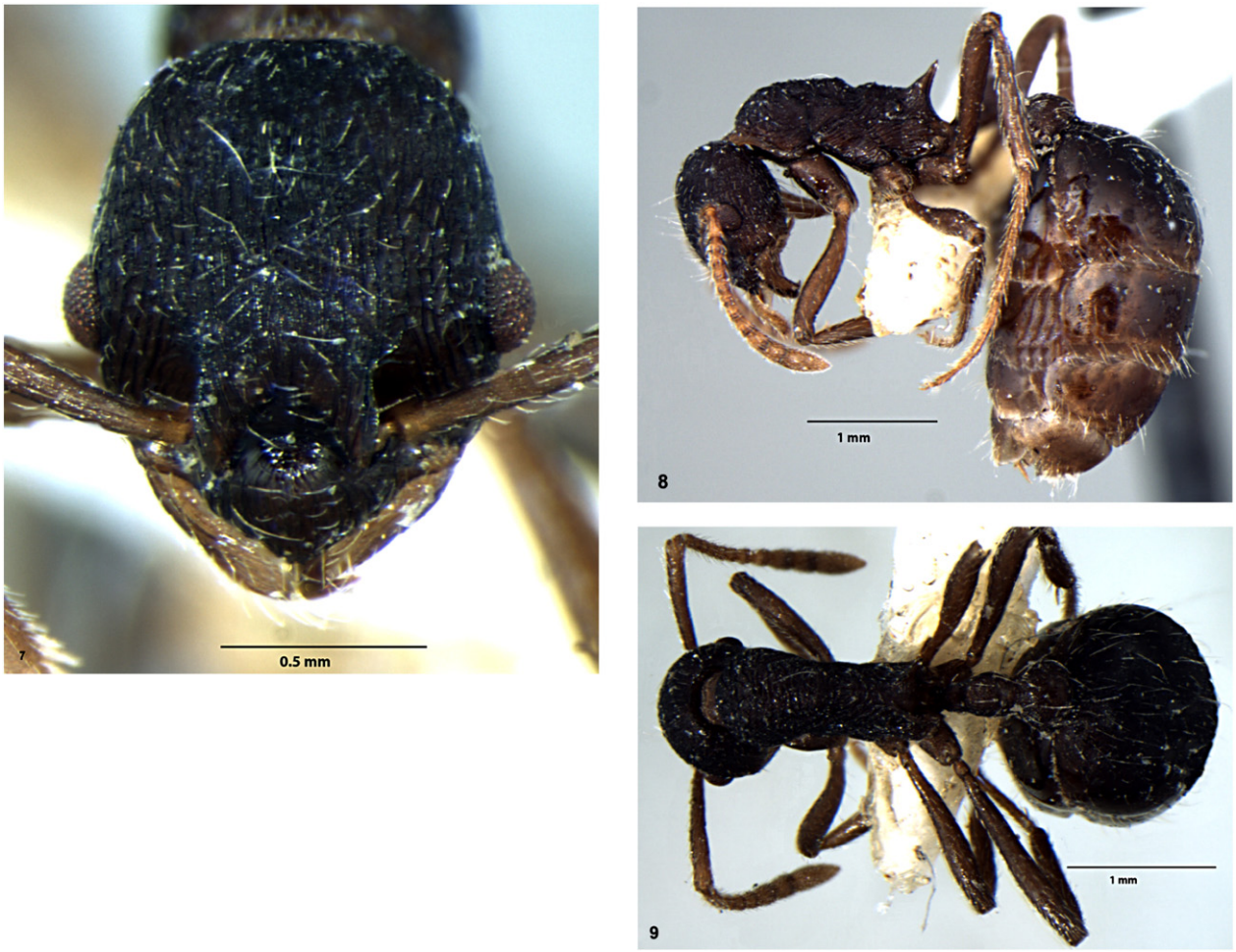
*Description*. Worker (Figs. 10–12, Table 2). Head longer than wide, with slightly convex sides and rounded occipital corners; mandible with 8 teeth (apical and preapical ones are the largest), longitudinally rugulose; clypeus convex, pointed anteriorly, with coarse longitudinal rugae; frontal triangle smooth and shiny; frontal lobes narrow, frontal carinae curved outward to merge with the rugae that surround the antennal sockets; only frons with longitudinal rugae, rest of the head reticulate; antennae 12 segmented with a 4 segmented club, feebly curved at base, without any trace of lobe or carina, longitudinally rugulose, ¼$^{th}$ longer than head length.

Mesosoma in profile convex, pro-mesonotal dorsum coarsely reticulate, rugose with few transverse rugae on mesonotum; sides of the pronotum with transverse rugae, rest of the mesosoma longitudinally rugose; metanotal groove longitudinally rugulose; propodeal dorsum with short transverse rugae, surface between rugae smooth and shiny; propodeal spines thick, long and straight, not curved at tips, surface between their bases transversally rugulose, declivity smooth and shiny, propodeal lobes rounded; petiole with long peduncle but reduced sub-petiolar process, dorsum of peduncle weakly rugulose, petiolar node concave anteriorly, rounded above, punctulate and reticulate, sides reticulate; postpetiolar dorsum rugulose, sides longitudinally rugulose. Gaster smooth and shiny.

Short sub-decumbent hairs on sides of the head, long erect hairs on whole head dorsum including the clypeus, mesosoma, petiole, postpetiole and gaster. Short suberect hairs present on gaster as well. Head, mesosoma, petiole, postpetiole and gaster brownish-black; mandibles, legs and antennae yellowish brown.

Males and gynes unknown.

*Differential diagnosis*. *Myrmica kothiensis* sp. nov. belongs to *inezae* species group as it possesses long peduncle, long propodeal spines and antennae feebly curved at the base without any trace of lobe or carina, but it well differs from *M. inezae*, *M. radchenkoi* and *M. rigatoi* by the presence of coarse reticulation on pronotal dorsum, transverse rugosity on meso-propodeal dorsum, and other morphometric




**Figs. 7–9.** *Myrmica curvispinosa* sp.nov., (Ergatoid) 7. Head in full-face view; 8. body, lateral view; 9. body, dorsal view.

differences (ESLI 0.33, ESDI 1.54 and ESL 0.28–0.31) (in *M. inezae* whole of the mesosoma dorsum with transversal rugae, in *M. radchenkoi* with longitudinal rugae on pronotum, and in *M. rigatoi* with reticulate sculpture on whole mesosoma, in *M. inezae* ESLI 0.42, ESDI 1.36 and ESL 0.39, in *M. radchenkoi* ESLI 0.42, ESDI 1.18 and ESL 0.34–0.36, and in *M. rigatoi* ESLI 0.52, ESDI 0.95 and ESL 0.46) (Table 4). *M. kothiensis* sp. nov. also well differs from its closely related newly discovered *M. curvispinosa* sp. nov. and *M. religiosa* sp. nov. In *M. curvispinosa* sp. nov. propodeal spines are curved at tips, and sides of the pronotum with transverse rugae, but in *M. kothiensis* sp. nov. spines are not curved, and sides of the pronotum with reticulate sculpture. In *M. religiosa* sp. nov. propodeal dorsum has longitudinal rugosity and propodeal spines are very long (ESLI 0.37–0.44), but in *M. kothiensis* sp. nov. propodeal dorsum has transverse rugosity and propodeal spines are comparatively shorter (ESLI 0.32–0.35).

*Etymology*. The species is named after its type locality, Kothi.

*Ecology*. The species was collected from a patchy *Cedrus* forest with grass cover. The workers were collected from under a stone in highly moist soil. The area is located under the foothills of Peer-Panjal range of the Himalayas and is covered with snow from October to mid-March.

*Myrmica religiosa* Bharti et Gul sp. nov.

*Material examined*. Holotype Worker, India, Uttarakhand, Chourangi khaal, 30.683614°N, 78.432684°E, 2300 m, 02.vi.2010; paratypes: 20 workers, from the nest of holotype. All specimens are in PUAC (DST 1757/92). One paratype will be deposited in BMNH.

*Description*. Worker (Figs. 13–15, Table 3). Head longer than wide, with feebly convex occipital corners; mandibles with 8–9 teeth (apical and preapical ones are the largest), longitudinally rugulose, without punctures; clypeus convex, pointed anteriorly, longitudinally rugose, surface between rugae smooth and shiny; frontal triangle highly polished, smooth and shiny; frontal carinae curved outwards to merge with the rugae that surround the antennal sockets; only anterior part of frons with longitudinal rugae, remaining part of head dorsum reticulate, surface between rugae appears shiny; antennae 12 segmented with 4 segmented club, scape feebly curved at base, without any trace of lobe or carina, ¼$^{th}$ longer than head, longitudinally rugulose, punctulate.

Mesosoma forming a regular arch in profile, promesonotal suture indistinct dorsally, pronotal dorsum reticulate anteriorly; mesonotal dorsum transversally rugose; metanotal groove longitudinally rugose; propodeal dorsum with longitudinal rugae (propodeum reticulate in some specimens) except for a single transverse ruga on anterior side; propodeal spines thick, long and pointed, not curved at tips, propodeal lobes rounded, declivity smooth and shiny; sides of pronotum transversally rugose, rest of the mesosoma with longitudinal rugae, without punctures, rugae on sides of mesosoma do not merge with rugae on propodeal dorsum; petiole with long peduncle and well developed sub-petiolar process, peduncle and anterior face of petiolar node with faint longitudinal rugulosity, petiolar node concave anteriorly,


**Figs. 10–12.** *Myrmica kothiensis* sp.nov., (Worker) 10. Head in full-face view; 11. body, lateral view; 12. body, dorsal view.

**Table 2**
The mean, standard deviation, minimum and maximum values (in mm) of the measurements and indices of *M. kothiensis* sp. nov.

| | | Holotype | Workers (4) | | |
|---|---|---|---|---|---|
| | | | Mean ± SD | Min | Max |
| Measurements | FLW | 0.41 | 0.41 ± 0.02 | 0.38 | 0.43 |
| | FW | 0.39 | 0.39 ± 0.02 | 0.36 | 0.41 |
| | HL | 1.12 | 1.15 ± 0.05 | 1.09 | 1.16 |
| | PL | 0.55 | 0.57 ± 0.04 | 0.53 | 0.64 |
| | PH | 0.34 | 0.34 ± 0.01 | 0.33 | 0.38 |
| | ESL | 0.28 | 0.29 ± 0.01 | 0.28 | 0.31 |
| | HW | 0.86 | 0.88 ± 0.04 | 0.83 | 0.93 |
| | SL | 0.98 | 1.00 ± 0.03 | 0.98 | 1.05 |
| | PPH | 0.36 | 0.38 ± 0.02 | 0.36 | 0.40 |
| | PW | 0.28 | 0.29 ± 0.03 | 0.26 | 0.33 |
| | PPW | 0.39 | 0.40 ± 0.02 | 0.39 | 0.49 |
| | PPL | 0.36 | 0.38 ± 0.02 | 0.33 | 0.43 |
| | PNW | 0.64 | 0.66 ± 0.03 | 0.62 | 0.71 |
| | ESD | 0.43 | 0.46 ± 0.05 | 0.41 | 0.53 |
| | AL | 1.52 | 1.62 ± 0.08 | 1.52 | 1.73 |
| | AH | 0.65 | 0.65 ± 0.03 | 0.61 | 0.71 |
| | SCL | – | – | – | – |
| | SCW | – | – | – | – |
| | GL | 1.40 | 1.42 ± 0.12 | 1.26 | 1.58 |
| | GW | 0.85 | 0.85 ± 0.06 | 0.76 | 0.93 |
| | TL | 4.95 | – | – | – |
| Indices | FI | 0.45 | 0.44 ± 0.01 | 0.41 | 0.45 |
| | CI | 1.30 | 1.30 ± 0.01 | 1.26 | 1.31 |
| | $SI_1$ | 0.88 | 0.87 ± 0.02 | 0.84 | 0.95 |
| | $SI_2$ | 1.14 | 1.13 ± 0.03 | 1.09 | 1.18 |
| | FLI | 1.05 | 1.06 ± 0.02 | 1.05 | 1.11 |
| | $PI_1$ | 1.62 | 1.67 ± 0.07 | 1.62 | 1.78 |
| | $PI_2$ | 0.64 | 0.64 ± 0.03 | 0.62 | 0.69 |
| | $PI_3$ | 0.33 | 0.33 ± 0.02 | 0.31 | 0.37 |
| | $PPI_1$ | 1.00 | 1.01 ± 0.03 | 0.98 | 1.05 |
| | $PPI_2$ | 0.92 | 0.94 ± 0.01 | 0.92 | 0.95 |
| | $PPI_3$ | 1.39 | 1.38 ± 0.08 | 1.27 | 1.46 |
| | $PPI_4$ | 0.45 | 0.46 ± 0.01 | 0.44 | 0.47 |
| | ESLI | 0.33 | 0.33 ± 0.01 | 0.32 | 0.35 |
| | ESDI | 1.54 | 1.57 ± 0.11 | 1.41 | 1.71 |

**Table 3**
The mean, standard deviation, minimum and maximum values (in mm) of the measurements and indices of *M. religiosa* sp. nov.

| | | Holotype | Workers (20) | | |
|---|---|---|---|---|---|
| | | | Mean ± SD | Min | Max |
| Measurements | FLW | 0.50 | 0.49 ± 0.01 | 0.47 | 0.5 |
| | FW | 0.47 | 0.46 ± 0.01 | 0.45 | 0.48 |
| | HL | 1.25 | 1.25 ± 0.02 | 1.21 | 1.27 |
| | PL | 0.69 | 0.67 ± 0.02 | 0.65 | 0.70 |
| | PH | 0.40 | 0.38 ± 0.01 | 0.37 | 0.40 |
| | ESL | 0.41 | 0.40 ± 0.02 | 0.36 | 0.41 |
| | HW | 1.00 | 0.99 ± 0.02 | 0.96 | 1.01 |
| | SL | 1.11 | 1.11 ± 0.01 | 1.08 | 1.12 |
| | PPH | 0.46 | 0.46 ± 0.01 | 0.44 | 0.49 |
| | PW | 0.33 | 0.31 ± 0.03 | 0.26 | 0.32 |
| | PPW | 0.50 | 0.48 ± 0.02 | 0.46 | 0.5 |
| | PPL | 0.46 | 0.47 ± 0.02 | 0.45 | 0.5 |
| | PNW | 0.73 | 0.73 ± 0.01 | 0.71 | 0.75 |
| | ESD | 0.53 | 0.51 ± 0.01 | 0.49 | 0.53 |
| | AL | 1.88 | 1.85 ± 0.02 | 1.84 | 1.88 |
| | AH | 0.75 | 0.71 ± 0.02 | 0.68 | 0.73 |
| | SCL | – | – | – | – |
| | SCW | – | – | – | – |
| | GL | 1.84 | – | – | – |
| | GW | – | – | – | – |
| | TL | 6.12 | – | – | – |
| Indices | FI | 0.47 | 0.46 ± 0.01 | 0.45 | 0.48 |
| | CI | 1.25 | 1.26 ± 0.02 | 1.24 | 1.29 |
| | $SI_1$ | 0.89 | 0.89 ± 0.01 | 0.86 | 0.91 |
| | $SI_2$ | 1.11 | 1.12 ± 0.02 | 1.07 | 1.15 |
| | FLI | 1.06 | 1.05 ± 0.02 | 1.04 | 1.07 |
| | $PI_1$ | 1.73 | 1.75 ± 0.05 | 1.67 | 1.84 |
| | $PI_2$ | 0.69 | 0.68 ± 0.02 | 0.66 | 0.71 |
| | $PI_3$ | 0.33 | 0.32 ± 0.03 | 0.26 | 0.33 |
| | $PPI_1$ | 1.00 | 1.03 ± 0.05 | 0.98 | 1.11 |
| | $PPI_2$ | 0.92 | 0.95 ± 0.02 | 0.92 | 0.98 |
| | $PPI_3$ | 1.52 | 1.56 ± 0.18 | 1.47 | 1.92 |
| | $PPI_4$ | 0.50 | 0.49 ± 0.01 | 0.47 | 0.50 |
| | ESLI | 0.41 | 0.40 ± 0.03 | 0.37 | 0.44 |
| | ESDI | 1.29 | 1.28 ± 0.06 | 1.19 | 1.24 |

**Table 4**
The mean, standard deviation, minimum and maximum values (in mm) of the measurements and indices of already described species of *inezae* species group (*M. inezae*, *M. radchenkoi* and *M. rigatoi*).

| | | *M. inezae* workers (3) | | | *M. radchenkoi* workers (4) | | | *M. rigatoi* (worker 1) |
|---|---|---|---|---|---|---|---|---|
| | | Mean ± SD | Min | Max | Mean ± SD | Min | Max | |
| Measurements | FLW | 0.45 ± 0.02 | 0.43 | 0.46 | 0.40 ± 0.01 | 0.39 | 0.40 | 0.42 |
| | FW | 0.42 ± 0.03 | 0.44 | 0.39 | 0.39 ± 0.01 | 0.38 | 0.39 | 0.36 |
| | HL | 1.21 ± 0.06 | 1.28 | 1.16 | 1.10 ± 0.03 | 1.07 | 1.13 | 1.14 |
| | PL | 0.63 ± 0.01 | 0.63 | 0.62 | 0.57 ± 0.01 | 0.56 | 0.58 | 0.56 |
| | PH | 0.39 ± 0.01 | 0.40 | 0.38 | 0.31 ± 0.01 | 0.30 | 0.32 | 0.34 |
| | ESL | 0.37 ± 0.05 | 0.40 | 0.31 | 0.35 ± 0.01 | 0.34 | 0.36 | 0.46 |
| | HW | 0.94 ± 0.04 | 0.98 | 0.90 | 0.85 ± 0.03 | 0.81 | 0.88 | 0.88 |
| | SL | 1.05 ± 0.05 | 1.10 | 1.00 | 0.99 ± 0.02 | 0.96 | 1.01 | 1.12 |
| | PPH | 0.43 ± 0.01 | 0.44 | 0.42 | 0.36 ± 0.03 | 0.33 | 0.39 | 0.42 |
| | PW | 0.31 ± 0.01 | 0.32 | 0.30 | 0.25 ± 0.01 | 0.24 | 0.25 | 0.27 |
| | PPW | 0.45 ± 0.02 | 0.46 | 0.42 | 0.36 ± 0.01 | 0.36 | 0.37 | 0.38 |
| | PPL | 0.47 ± 0.03 | 0.50 | 0.45 | 0.39 ± 0.03 | 0.36 | 0.42 | 0.42 |
| | PNW | 0.73 ± 0.04 | 0.76 | 0.68 | 0.60 ± 0.01 | 0.58 | 0.60 | 0.64 |
| | ESD | 0.53 ± 0.03 | 0.55 | 0.50 | 0.42 ± 0.01 | 0.41 | 0.42 | 0.44 |
| | AL | 1.84 ± 0.11 | 1.86 | 1.72 | 1.56 ± 0.05 | 1.49 | 1.61 | 1.64 |
| | AH | 0.73 ± 0.06 | 0.66 | 0.78 | – | – | – | – |
| | SCL | – | – | – | – | – | – | – |
| | SCW | – | – | – | – | – | – | – |
| | GL | – | – | | – | – | – | – |
| | GW | – | – | – | – | – | – | – |
| | TL | 5.88 | – | – | 5.09 | – | – | – |
| Indices | FI | 0.44 ± 0.01 | 0.45 | 0.43 | 0.45 | 0.43 | 0.48 | 0.41 |
| | CI | 1.29 ± 0.04 | 1.32 | 1.25 | 1.29 | 1.27 | 1.32 | 1.30 |
| | $SI_1$ | 0.87 ± 0.02 | 0.89 | 0.86 | 0.90 | 0.89 | 0.90 | 0.98 |
| | $SI_2$ | 1.13 ± 0.05 | 1.18 | 1.08 | 1.17 | 1.14 | 1.19 | 1.28 |
| | FLI | 1.07 ± 0.04 | 1.10 | 1.02 | 1.03 | 1.02 | 1.05 | 1.17 |
| | $PI_1$ | 1.61 ± 0.04 | 1.66 | 1.58 | 1.86 | 1.81 | 1.87 | 1.00 |
| | $PI_2$ | 0.67 ± 0.02 | 0.69 | 0.64 | 0.67 | 0.65 | 0.69 | 0.64 |
| | $PI_3$ | 0.33 ± 0.01 | 0.34 | 0.33 | 0.29 | 0.28 | 0.30 | – |
| | $PPI_1$ | 1.09 ± 0.06 | 1.16 | 1.05 | 1.08 | 1.06 | 1.11 | 1.00 |
| | $PPI_2$ | 0.96 ± 0.03 | 1.00 | 0.93 | 1.00 | 0.92 | 1.05 | 0.90 |
| | $PPI_3$ | 1.43 ± 0.02 | 1.44 | 1.40 | 1.48 | 1.44 | 1.50 | 1.41 |
| | $PPI_4$ | 0.48 ± 0.02 | 0.49 | 0.47 | 0.43 | 0.42 | 0.44 | – |
| | ESLI | 0.39 ± 0.04 | 0.42 | 0.34 | 0.42 | 0.41 | 0.43 | 0.52 |
| | ESDI | 1.45 ± 0.14 | 1.61 | 1.36 | 1.18 | 1.14 | 1.21 | 0.95 |

sides reticulate; postpetiole sub-globular, longitudinally rugulose, without punctures. Gaster smooth and shiny.

Short sub-decumbent hairs on all over the head, more dense on sides. Long erect hairs on dorsum of head, clypeus, mesosoma, petiole, postpetiole and gaster. Short suberect hairs are also present on gaster. Head, mesosoma, petiole and postpetiole and gaster brownish black; mandibles, antennae and legs reddish brown.

*Differential diagnosis*. *Myrmica religiosa* sp. nov. shows some intermediate characters between *Myrmica inezae* and other species of the *inezae* species group (promesonotal dorsum and sides of the pronotum with transverse rugosity), but longitudinal sculpture of the propodeum clearly separates it from *M. inezae*. *M. religiosa* sp. nov. differs from *M. curvispinosa* sp. nov. by a smooth postpetiolar dorsum and a straight propodeal spine, as in *M. curvispinosa* sp. nov. the postpetiolar dorsum is longitudinally rugulose and has a curved propodeal spine. Both *Myrmica kothiensis* sp. nov. and *Myrmica religiosa* sp. nov. have longitudinal rugae on the metanotal groove and longitudinal rugulae on the postpetiole, but *Myrmica religiosa* sp. nov. differs from the latter by the very long propodeal spines and long petiole: ESLI 0.37–0.44, $PI_1$ 1.73 and ESDI 1.19–1.24 *vs.* ESLI 0.32–0.35, $PI_1$ 1.62 and ESDI 1.41–1.71 in *Myrmica kothiensis* sp. nov.

*Etymology*. The specific epithet refers to its type locality Chaurangi khal (Nachiketa taal) which is of religious glory. The famous worship place of Nachiketa, the child protagonist in ancient Hindu fable.

*Ecology*. *Myrmica religiosa* sp. nov. has been collected by hand under stones in a dry forested area of Chourangi khal. The forest is inhabited by the *Cedrus*, Oak and *Rhododendron*, surrounded by patches of *Pinus*. The area has numerous anthropogenic activities. The recorded temperature and humidity at the collection site was as 30 °C and 65%.

## Key for the identification of species of the *Myrmica inezae* species group (workers)

(*M. mixta* Radchenko et Elmes is known only from gyne and excluded from the key).

1 Whole mesosoma dorsum or at least part of it with coarse transverse rugae. Propodeal spines comparatively shorter (ESLI<0.45) …….. 2.
– Mesosoma dorsum with sinuous rugae and coarse reticulations, but never transverse rugae. Propodeal spines longer (ESLI 0.52) – North-eastern Pakistan …….. *M. rigatoi* Radchenko et Elmes
2 (1) Whole mesosoma dorsum with transverse rugae. – India: Himachal Pradesh ……*M. inezae* Forel.
– Part of mesosoma dorsum with transverse rugosity. ……....3
3 (2) Petiolar node with coarse transversally concentric rugae. Part of the pronotum with longitudinal rugae. Petiole with a very long peduncle ($PI_1$ > 1.86). – India: Jammu and Kashmir ……..……..*M. radchenkoi* Bharti et Sharma.
–Petiolar node never with transverse rugae. Pronotum either reticulate or with transverse coarse rugae, but never with longitudinal rugae. Petiole with comparatively short peduncle ($PI_1$ < 1.78)…….....4




**Figs. 13–15.** *Myrmica religiosa* sp.nov., (Worker) 13. Head in full-face view; 14. body, lateral view; 15. body, dorsal view.

4 (3) Petiolar dorsum feebly reticulate and punctured. Postpetiole smooth and shiny. Sides of the pronotum reticulate. Propodeal spines feebly curved at the tips. – India: Himachal Pardesh ……..*Myrmica curvispinosa* sp. nov.
– Petiolar dorsum feebly reticulate, without punctures. Postpetiole rugulose and with few longitudinal striations. Sides of the pronotum with transverse rugae. Propodeal spines not curved……..5

5 (4) Propodeum longitudinally rugose. Propodeal spines longer than the distance between their tips, ESDI < 1.24, petiole long ($PI_1$ 1.73.) – India: Uttarakhand……*Myrmica religiosa* sp. nov.
– Propodeum transversally rugose. Propodeal spines shorter than the distance between their tips, ESDI > 1.41, petiole comparatively short ($PI_1$ 1.62.) – India: Himachal Pardesh.....*Myrmica kothiensis* sp. nov.

## Discussion

As discussed above, species of the *inezae* group have quite distinct features: petiole with a very long and thin peduncle, postpetiole subglobular, propodeal spines very long, propodeal lobes rounded, partly transverse rugosity on mesosoma except for *M. rigatoi*. Thus, the discovery of these three new species would add to further the understanding of the taxonomy and distribution of the *Myrmica inezae* species group.

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