

# Altitudinal Diversity of Ants in Himalayan Regions (Hymenoptera: Formicidae)

by

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## ABSTRACT

Altitudinal diversity of ants in the Himalayan region is discussed in detail for the first time. The region has been colonized by Indo-Malayan, Indian and other elements, apart from a high degree of endemic elements. Most of the ant genera recorded originated much earlier than the Himalayas and basal forms of a few (e.g., *Myrmica*) are concentrated here. The number of endemic elements appears to be much higher (about 46%) as compared to other elements. 115 ant species out of 202 reach up to or cross an altitude of 2000 metes above mean sea level and penetrate into the Palaearctic zone; 71 of these are endemic. Which factors are responsible for such a high degree of endemism and altitudinal range are to be a point of contention for evolutionary biologists in coming years.

## INTRODUCTION

The Himalayan region is currently listed as a fragile ecosystem. Since its origin in the Paleogene period, the region has been colonized at different times by Malayan, Afrotropical, Mediterranean, Central Asian and Temperate elements. The rigorous environment has further acted upon this mosaic of geographical forms, leading to the extinction of species, breaking up of distributional ranges and eventually to the induction of genetic variations with or without speciation. Thus the flora and fauna have passed through various transitional stages during the geomorphological evolution of this region.

The Himalayan system stretches over 3000 kilometers, from Myanmar to east of Afghanistan (between longitudes 72° and 98° East and latitudes 27° and 36° North) and its width ranges from 80 kilometers to 300 kilometers (Mani

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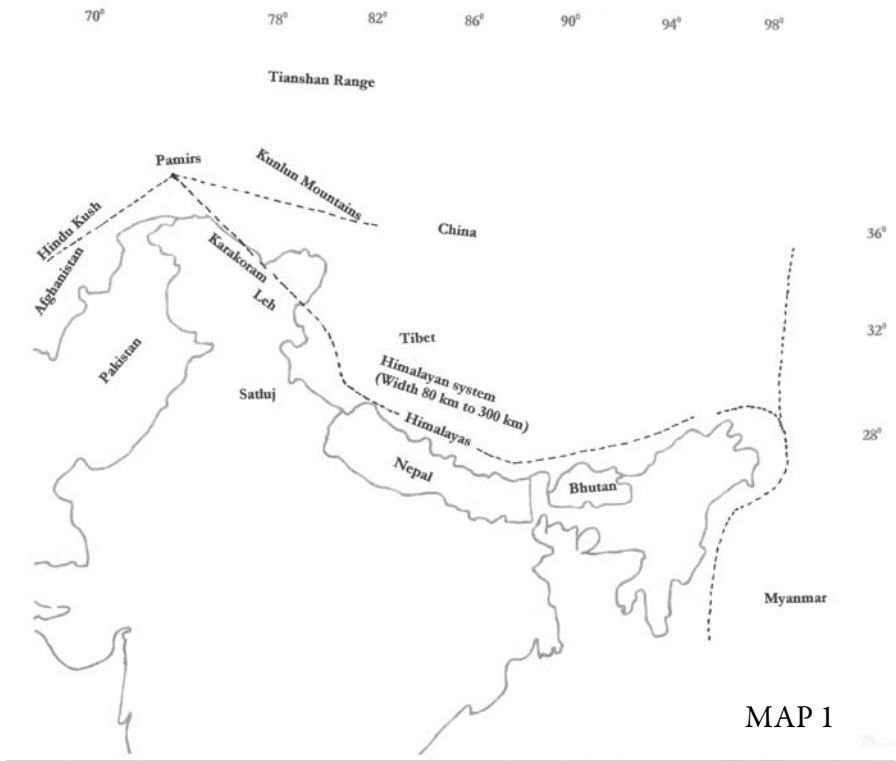
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1962, 1968, 1978 & Wadia 2001). The Himalayas proper are considered a mountain system from east of Brahmaputra to the bend of Indus in the west, but the Himalayan system continues from Myanmar to Afghanistan. Keun Lun represents the northern extreme of the Himalayan range, followed by the Tibetan plateau. The mountain system meets with high ranges of Central Asia (Hindu Kush, Trans Karakoram, Tian Shan, Kun Lun, Trans Alai) forming Pamir Knot, and to the north-east lies Tibet (Map 1). Geographical Division of the region includes (Mani 1962, 1968, 1978 and Wadia 2001, shown in Map 3):

The Eastern or Assam Himalayas: Between Namcha Barva peak (about 7750 meters above mean sea level) east of Brahmaputra and the Tista river in the west; a span of 720 kilometers.

The Nepalese or Central Himalayas: Between the Tista river and Kali in the west; stretch of about 800 kilometers. Mount Everest, Kanchenjunga, Makalu, and Dhaulagiri fall in this range.

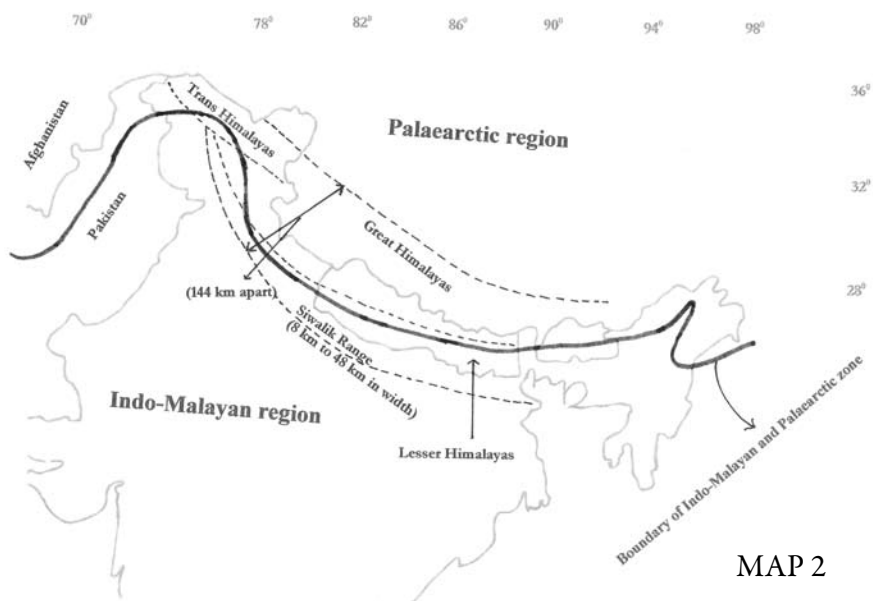


The Kumaon Himalayas: Between the Kali river and Satluj; Naini Tal, Almora and Garhwal with Nanda Devi, Badrinath, Gangotri and Kedarnath fall in this range. This stretch is of about 320 kilometers.

The North-West Himalayas: Between west of Satluj and east of the bend of Indus, just beyond Nanga Parbat, about 560 kilometers long. Karakoram, Ladakh, Zaskar and Lahaul fall in this range.

The Himalayas are not a single mountain chain, but a complex series of converging or parallel and bifurcating ranges, intersected by high longitudinal valleys and high plateaus. The ranges are: the Siwalik Range, the lesser Himalayan Range, the great Himalayan range and the trans-Himalayan range (Map 2).

Himalayan ecology is temperature-dependent. The snow line occurs at an average of 6000 meters above mean sea level and the timber line at an average of 3000 meters (the highest altitude at which the forest ends). With this sort of environment, the micro-climate plays an important role for insects like ants, and such insects show varied degrees of adaptability to cope, survive and reproduce. The temperature, which is a crucial factor, shows a gradual decrease with increasing altitude. Ants have shown remarkable adaptations as compared to other insects in colonizing such a hostile environment. It is



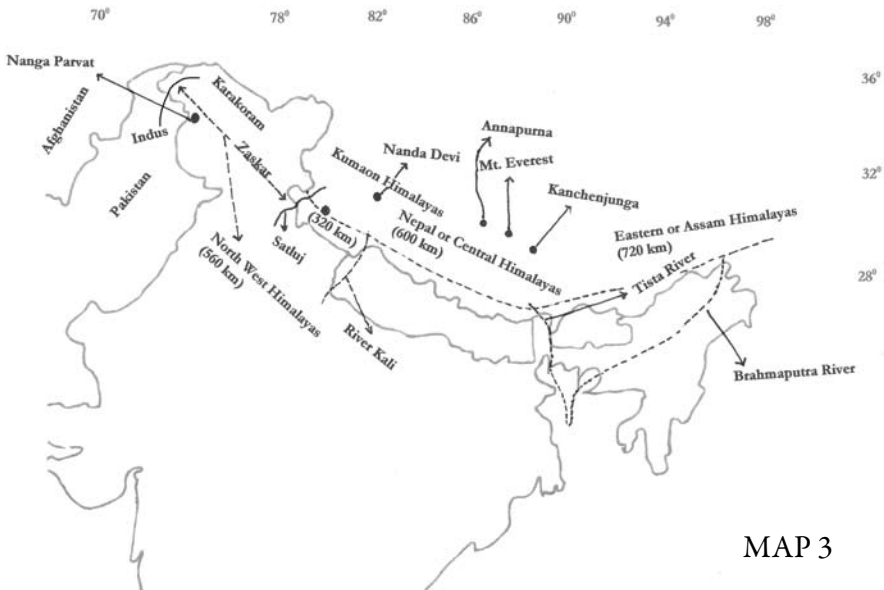
MAP 2

quite significant that the diversification of regional ants and the development of the Himalayas occurred almost at the same time.

Bio-diversity assessments are conducted on a global scale for the purpose of conservation or to determine the role of insects as indicators of ecosystem health, but our knowledge of biota still remains poor either due to lack of information or dissemination and proper utilization of gathered data. However, GBIF, GTI, various universities and museums are trying hard to meet this challenge. From the Himalayan region, scattered inputs regarding ants (listed comprehensively in the reference section) have poured in time and again after Bingham's fauna (1903). This has generated a chaotic state of affairs with no comprehensive assessment available from this montane system which could reflect altitudinal ranges of taxa, endemism and penetration of other elements, on the basis of which zoogeographical affinities with adjoining regions, conservation measures and other ecological parameters could be judged. The present work attempts to contribute to this knowledge.

## MATERIALS AND METHODS

Compilation of this data has been an arduous task, given the circumstances that the distributional ranges of many taxa (which have already been reported



MAP 3

from the Himalayas) are not listed in catalogues of ants such as Bolton *et al.* (2007). Probably either the region was not given due attention or the data reported was not pleaded/presented properly (due to the fact that no native myrmecologist/entomologist or even institutes like ZSI established by the Government of India for this very purpose bothered much about it). This led to many communications with fellow myrmecologists (duly acknowledged in the acknowledgment section).

The data presented here include a thorough scanning of literature related to the Himalayan region (including the central Himalayas, which are part of Nepal), inputs from my visit to NHM, London, collections by Professor Seike Yamane from Nepal and Pakistan and finally my own collections from the Himalayan region since 1999. The taxa included in the present paper either reach up to or cross an altitude of 1000 meters above mean sea level, as the typical Himalayan conditions start manifesting at or above this altitude. For the species listed, I feel comfortable in using the term Indo-Malayan region (used quite prolifically in literature related to the Indian subcontinent and the Himalayas) with few exceptions, where the geographical range and particular altitude could not be assessed.

Abbreviations used in the text include: M (Meters), ZSI (Zoological Survey of India), NHM (Natural History Museum, London), GBIF (Global Biodiversity information Facility), GTI (Global Taxonomic Initiative).

## RESULTS

The results of this compilation are given in Table 1.

## DISCUSSION

As elucidated by Moreau *et al.* (2006) the diversification of major ant lineages occurred from the beginning of the early Paleocene to the late Cretaceous, 60 to 100 million years ago in the age of angiosperms. Interestingly, it's the same time span during which the formation of the Himalayas occurred. The initial mountain building processes were underway about 70 million years ago when the North moving Indo-Australian plate collided with the Eurasian plate, followed by a second phase of mountain development about 65 million years ago. Current estimates (International Commission on Stratigraphy, 2004) indicate that about 50 million years ago the Greater, Trans and lesser

Himalayan ranges (except the low Siwalik ranges whose origin is estimated to be 25 million years ago) were formed in Eocene, and when India collided with Eurasia considerable faunal exchange occurred. In this pretext, the present data brings out very interesting results pertaining to ants. Indo-Malayan elements which have penetrated the Himalayan regions amount to 22.27%

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level.

Species	Range	Locality
<b>Myrmicinae</b>		
<i>Pheidole</i> Westwood		
1. <i>Pheidole latinoda angusitor</i> Forel, 1902	250-1500 M	(Indo-Malaya)
2. <i>Pheidole jucunda</i> r. <i>fossulata</i> Forel, 1902	250-2200 M	(Himalayas)
3. <i>Pheidole jucunda</i> Forel, 1885	250- 3600 M	(Indo-Malaya)
4. <i>Pheidole sagei</i> Forel, 1902	2000-4500 M	(Himalayas)
5. <i>Pheidole indica</i> r. <i>bimalayana</i> Mayr, 1879	1200-2000 M	(Indo-Malaya)
6. <i>Pheidole malinsii</i> Forel, 1902	1000-3000 M	(Indo-Malaya)
7. <i>Pheidole grayi</i> Forel, 1902	1500 M	(India)
8. <i>Pheidole templaria</i> Forel, 1902	1500-2000 M	(Himalayas)
9. <i>Pheidole pronotalis</i> Forel, 1902	1500 M	(Indo-Malaya)
10. <i>Pheidole woodmasoni</i> Forel, 1885	up to 1000 M	(Indo-Malaya)
11. <i>Pheidole roberti</i> Forel, 1902	1400 M	(Indo-Malaya)
12. <i>Pheidole fervens fervens</i> ( <i>dharamsalana</i> ) Smith, F., 1858	1580 M	(Indo-Malaya)
13. <i>Pheidole indica</i> ( <i>striativentris</i> ) Mayr, 1879	250-1000 M	(Indo-Malaya)
14. <i>Pheidole rogersi</i> Forel, 1902	up to 1000 M	(India)
15. <i>Pheidole bhavanae</i> Bingham, 1903	3000 M	(Himalayas)
16. <i>Pheidole smythiesii smythiesii</i> Forel, 1902	1300-2200 M	(India, Vietnam)
17. <i>Pheidole</i> sp.	1158 M	(Himalayas)
18. <i>Pheidole noda noda</i> Smith, F., 1874	1200 M	(Indo-Malaya)
<i>Aphaenogaster</i> Mayr		
1. <i>Aphaenogaster beesoni</i> Donisthorpe, 1933	1676 M	(Himalayas)
2. <i>Aphaenogaster sagei sagei</i> (Forel, 1902)	3400 M	(Himalayas)
3. <i>Aphaenogaster smythiesii prudens</i> (Forel, 1902)	1700-2900 M	(Himalayas)
4. <i>Aphaenogaster cristata</i> (Forel, 1902)	1000-3400 M	(Himalayas)
5. <i>Aphaenogaster rothmeyei</i> (Forel, 1902)	1000-3400 M	(India)
6. <i>Aphaenogaster sagei pachei</i> (Forel, 1906)	3900-4800 M	(Himalayas)
7. <i>Aphaenogaster annandalei</i> Mukerjee, 1930	2200 M	(Himalayas)
8. <i>Aphaenogaster cavernicola</i> Donisthorpe, 1938	2200 M	(Himalayas)
<i>Cardiocondyla</i> Emery		
1. <i>Cardiocondyla mauritanica</i> Forel, 1890	250-1219 M	(Oriental, Palaearctic, Ethiopia)
2. <i>Cardiocondyla kagutsuchi</i> Terayama, 1999	800-1000 M	(Australia, Indo-Malaysia, Palaearctic)
3. <i>Cardiocondyla</i> sp.	1400 M	(Himalayas)
<i>Lophomyrmex</i> Emery		
1. <i>Lophomyrmex bedoti</i> Emery, 1893	180-1219 M	(Indo-Malaya)
2. <i>Lophomyrmex kali</i> Rigato, 1994	1000 M	(Himalayas)
3. <i>Lophomyrmex ambiguus</i> Rigato, 1994	600-1100M	(Himalayas)

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

Species	Range	Locality
<i>Tetramorium</i> Mayr		
1. <i>Tetramorium caespitum caespitum</i> ( <i>himalayanum</i> ) (Linnaeus, 1758)	2300-3400 M	(Himalayas)
2. <i>Tetramorium christiei</i> Forel, 1902	1200-2200M	(Himalayas)
3. <i>Tetramorium elisabethae</i> Forel, 1904	2000 M	(Himalayas)
4. <i>Tetramorium salvatum</i> Forel, 1902	up to 2000 M	(India)
5. <i>Tetramorium lanuginosum</i> Mayr, 1870	up to 1130 M	(Neotropical, Nearctic, Malagasy, Indo-Malaya)
<i>Perissomyrmex</i> Smith		
1. <i>Perissomyrmex nepalensis</i> Radchenko, 2003	2600-3000 M	(Himalayas)
<i>Meranoplus</i> Smith		
1. <i>Meranoplus bicolor</i> (Guerin-Meneville, 1844)	up to 1750 M	(Indo-Malaya)
<i>Carebara</i> Westwood		
1. <i>Carebara lignata</i> Westwood, 1840	1000 M	(Indo-Malaya)
<i>Myrmicaria</i> Saunders		
1. <i>Myrmicaria brunnea brunnea</i> Saunders, 1842	250-1000 M	(Indo-Malaya)
<i>Monomorium</i> Mayr		
1. <i>Monomorium sagei</i> Forel, 1902	2000 M	(Himalayas)
2. <i>Monomorium orientale</i> Mayr, 1879	up to 1600 M	(India, Philippines)
3. <i>Monomorium luisae</i> Forel, 1904	2000 M	(Himalayas)
4. <i>Monomorium atomum atomum</i> Forel, 1902	up to 2000 M	(India)
5. <i>Monomorium criniceps</i> (Mayr, 1879)	up to 1000 M	(Indo-Malaya)
6. <i>Monomorium glabrum</i> (Andre, 1883)	up to 1000 M	(India)
7. <i>Monomorium pharaonis</i> (Linnaeus, 1758)	up to 1000 M	(Tropical)
8. <i>Monomorium indicum indicum</i> Forel, 1902	up to 2500 M	(India, Myanmar, Afghanistan)
9. <i>Monomorium destructor</i> (Jerdon, 1851)	1200 M	(Neotropical, Malagasy)
<i>Temnothorax</i> Mayr		
1. <i>Temnothorax desioi desioi</i> (Menozi, 1939)	3200 M	(Himalayas)
2. <i>Temnothorax inermis</i> (Forel, 1902)	1500 M	(Himalayas)
3. <i>Temnothorax rothneyi rothneyi</i> (Forel, 1902)	2000-3100 M	(India)
4. <i>Temnothorax rothneyi simlensis</i> (Forel, 1904)	1500-3100 M	(Himalayas)
5. <i>Temnothorax wroughthonii</i> (Forel, 1904)	1981-3100 M	(Himalayas)
6. <i>Temnothorax fultonii</i> (Forel, 1902)	1500-3150 M	(Himalayas)
7. <i>Temnothorax desioi melanicus</i> (Menozi, 1939)	3200 M	(Himalayas)
<i>Messor</i> Forel		
1. <i>Messor himalayanus</i> (Forel, 1902)	1200-3400 M	(Himalayas, Afghanistan)
2. <i>Messor instabilis</i> (Smith, F., 1858)	1200-2400 M	(India)
<i>Crematogaster</i> Lund		
1. <i>Crematogaster sagei sagei</i> Forel, 1902	1600-2000 M	(Himalayas)
2. <i>Crematogaster binghamii</i> Forel, 1904	1000 M	(Himalayas)
3. <i>Crematogaster dalyi sikkimensis</i> Forel, 1904	1500 M	(Himalayas)
4. <i>Crematogaster ebenina ebenina</i> Forel, 1902	1500 M	(India)
5. <i>Crematogaster walshi walshi</i> Forel, 1902	up to 1500 M	(India)
6. <i>Crematogaster buddhae</i> Forel, 1902	up to 1200 M	(India)
7. <i>Crematogaster rothneyi rothneyi</i> Mayr, 1879	up to 1200 M	(India)
8. <i>Crematogaster himalayana</i> Forel, 1902	1500-2300 M	(Himalayas)

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

Species	Range	Locality
9. <i>Crematogaster rogenhoferi</i> Mayr, 1879	up to 1500 M	(Indo-Malaya)
10. <i>Crematogaster subnuda subnuda</i> Mayr, 1879	250-1638 M	(India)
11. <i>Crematogaster politula</i> Forel, 1902	1000-1300 M	(India)
<i>Myrmica</i> Latreille		
1. <i>Myrmica indica</i> Weber, 1950	2000-3150 M	(Himalayas)
2. <i>Myrmica urbanii</i> Radchenko and Elmes, 1998	1000-1900 M	(Himalayas)
3. <i>Myrmica boltoni</i> Radchenko and Elmes, 1998	2000-3500 M	(Himalayas)
4. <i>Myrmica martensi</i> Radchenko and Elmes, 1998	3200 M	(Himalayas)
5. <i>Myrmica collingwoodi</i> Radchenko and Elmes, 1998	2400-3100 M	(Himalayas)
6. <i>Myrmica rugosa</i> Mayr, 1865	1200-3400 M	(Himalayas)
7. <i>Myrmica rupestris</i> Forel, 1902	2100-3500 M	(Himalayas)
8. <i>Myrmica foreliana</i> Radchenko and Elmes, 2001	1219-2133M	(Himalayas)
9. <i>Myrmica aimonissabaudiae</i> Menozzi, 1939	1300-3450 M	(Himalayas, Afghanistan)
10. <i>Myrmica hecate</i> Weber, 1947	1300-3700 M	(Himalayas)
11. <i>Myrmica erepatrix</i> Bolton, 1988	2800 M	(Himalayas)
12. <i>Myrmica cachmiriensis</i> Forel, 1904	2100-3500 M	(Himalayas)
13. <i>Myrmica wardi</i> Radchenko and Elmes, 1999	2190-3450 M	(Himalayas)
14. <i>Myrmica ordinaria</i> Radchenko and Elmes, 1999	1999-2300 M	(Himalayas)
15. <i>Myrmica smythiesii</i> Forel, 1902	2100-3750 M	(Himalayas)
16. <i>Myrmica fortior</i> Forel, 1904	2000-2700 M	(Himalayas)
17. <i>Myrmica wittmeri</i> Radchenko and Elmes, 1999	2300-3700 M	(Himalayas)
18. <i>Myrmica inezae</i> Forel, 1902	1300-3000 M	(Himalayas, China)
19. <i>Myrmica rigatoi</i> Radchenko and Elmes, 1998	2200- 2300 M	(Himalayas)
20. <i>Myrmica pachei</i> Forel, 1906	2600-3400 M	(Himalayas)
21. <i>Myrmica villosa</i> Radchenko and Elmes, 1999	3300 M	(Himalayas)
22. <i>Myrmica tenuispina</i> Ruzsky, 1905	2700-4100 M	(Himalayas, Mid-Asian mountains)
23. <i>Myrmica kozlovi kozlovi</i> Ruzsky, 1915	4800 M	(Himalayas, Tibet)
24. <i>Myrmica brancuccii</i> Radchenko and Elmes, 1999	2400 M	(Himalayas)
25. <i>Myrmica vittata</i> Radchenko and Elmes, 1999	2200 M	(Himalayas)
26. <i>Myrmica williamsi</i> Radchenko and Elmes, 1999	2000 M	(Himalayas)
27. <i>Myrmica nitida</i> Radchenko and Elmes, 1999	2600-3600 M	(Himalayas)
28. <i>Myrmica rhytida</i> Radchenko and Elmes, 1999	2800-4200 M	(Himalayas)
29. <i>Myrmica petita</i> Radchenko and Elmes, 1999	2300-2400 M	(Himalayas)
30. <i>Myrmica afghanica</i> Radchenko and Elmes, 2003	1000-2000 M	(Himalayas, Hindukush)
<i>Strumigenys</i> Smith, F.		
1. <i>Strumigenys smythiesii</i> Forel, 1902	1200 M	(India)
Ponerinae		
<i>Pachycondyla</i> Smith, F.		
1. <i>Pachycondyla luteipes</i> (Mayr, 1862)	250-2200 M	(Indo-Malaya)
2. <i>Pachycondyla nigrita nigrita</i> (Emery, 1895)	1900 M	(Indo-Malaya)
3. <i>Pachycondyla rufipes rufipes</i> (Jerdon, 1851)	400-2000 M	(Indo-Malaya)
4. <i>Pachycondyla javana</i> (Mayr, 1867)	1704-3000 M	(Indo-Malaya)
<i>Gnamptogenys</i> Roger		
1. <i>Gnamptogenys meghalaya</i> Lattke, 2004	700-1000 M	(Himalayas)
<i>Myopopone</i> Roger		
1. <i>Myopopone castanea (moelleri)</i> Smith, F., 1860	1000 M	(Indo-Malaya, Phillipines & New guinea)

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

Species	Range	Locality
<i>Leptogenys</i> Roger		
1. <i>Leptogenys diminuta diminuta</i> Forel, 1900	1400-2500 M	(Indo-Malaya & Australia)
2. <i>Leptogenys lucidula</i> Emery, 1895	1300 M	(Indo-Malaya)
3. <i>Leptogenys moelleri</i> (Bingham, 1903)	1100 M	(Himalayas)
4. <i>Leptogenys punctiventris</i> (Mayr, 1879)	1300 M	(Indo-Malaya)
5. <i>Leptogenys kitteli kitteli</i> (Mayr, 1870)	up to 2200 M	(Indo-Malaya)
6. <i>Leptogenys diminuta laeviceps</i> (Smith, F., 1857)	250-1300 M	(India, Borneo)
<i>Diacamma</i> Mayr		
1. <i>Diacamma scalpratum scalpratum</i> (Smith, F., 1858)	1200 M	(Indo-Malaya)
2. <i>Diacamma rugosum</i> subsp. <i>sculptum</i> (Jerdon, 1851)	1524 M	(Indo-Malaya)
<i>Odontoponera</i> Mayr		
1. <i>Odontoponera transversa transversa</i> (Smith, F., 1857)	400-1200 M	(Indo-Malaya)
<i>Harpegnathos</i> Jerdon		
1. <i>Harpegnathos venator venator</i> (Smith, F., 1858)	1000 M	(Indo-Malaya)
<i>Odontomachus</i> Emery		
1. <i>Odontomachus monticola (punctulatus)</i> Emery, 1892	1900 M	(India, China, Taiwan, Japan, Vietnam)
Cerapachyinae		
<i>Cerapachys</i> Smith		
1. <i>Cerapachys sulcinodis (risii)</i> Emery, 1889	1200 M	(Indo-Malaya)
2. <i>Cerapachys longitarsus (parva)</i> (Mayr, 1879)	1000 M	(Indo-Malaya)
Formicinae		
<i>Plagiolepis</i> Mayr		
1. <i>Plagiolepis pontii</i> Menozzi, 1839	2800 M	(Himalayas)
2. <i>Plagiolepis balestrierii</i> Menozzi, 1839	2200-3700 M	(Himalayas)
3. <i>Plagiolepis dichroa</i> Forel, 1902	up to 1500 M	(India)
4. <i>Plagiolepis moelleri</i> Bingham, 1903	up to 2700 M	(Himalayas)
5. <i>Plagiolepis exigua exigua</i> Forel, 1894	3100 M	(India, Africa, China, Madagascar)
6. <i>Plagiolepis jerdonii</i> Forel, 1894	750-1230 M	(India)
<i>Oecophylla</i> Smith		
1. <i>Oecophylla smaragdina</i> (Fabricius, 1775)	250-1150 M	(Indo-Malaya)
<i>Lepisiota</i> Santschi		
1. <i>Lepisiota frauenfeldi integra</i> (Forel, 1894)	250-2700 M	(India, Afghanistan)
2. <i>Lepisiota capensis</i> Mayr, 1862	1650-3000 M	(Indo-Malaya)
3. <i>Lepisiota opaca opaca</i> (Forel, 1892)	340-1640 M	(India)
4. <i>Lepisiota modesta</i> (Forel, 1894)	2200 M	(Himalayas)
5. <i>Lepisiota rothmeyeri watsonii</i> Forel, 1894	1900-2800 M	(Myanmar, Himalayas)
6. <i>Lepisiota annandalei</i> (Mukerjee, 1930)	2133 M	(Himalayas)
<i>Lasius</i> Fabricius		
1. <i>Lasius alienus</i> (Foerster, 1850)	1000-3100 M	(Holarctic)
2. <i>Lasius brunneus brunneus</i> (Latreille, 1798)	1000-2300 M	(Palaeartic, Oriental)
3. <i>Lasius niger niger</i> (Linnaeus, 1758)	1400-3100 M	(Holarctic)
4. <i>Lasius alienoflavus</i> Bingham, 1903	1600-2300 M	(Himalayas)
5. <i>Lasius talpa</i> Wilson, 1955	1800-2800 M	(Himalayas, Japan, Korea)

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

Species	Range	Locality
6. <i>Lasius bicornis</i> (Foerster, 1850)	1000-2000 M	(India)
7. <i>Lasius crinitus</i> (Smith, F., 1858)	2000-3000 M	(Himalayas)
8. <i>Lasius draco</i> Collingwood, 1982	2640 M	(Himalayas)
9. <i>Lasius mikir</i> Collingwood, 1982	1500 M	(Himalayas)
10. <i>Lasius himalayanus</i> Bingham, 1903	1828-2700 M	(Himalayas)
11. <i>Lasius breviscapus</i> Seifert, 1992	2400-2750 M	(Himalayas)
12. <i>Lasius lawarai</i> Seifert, 1992	2400-2700 M	(Himalayas)
13. <i>Lasius hirsutus</i> Seifert, 1992	2700 M	(Himalayas)
14. <i>Lasius wittmeri</i> Seifert, 1992	2200-3100 M	(Himalayas)
15. <i>Lasius magnus</i> Seifert, 1992	3100 M	(Himalayas)
<i>Formica</i> Linnaeus		
1. <i>Formica fusca</i> Linnaeus, 1758	1700-4000 M	(Nearctic, Palaearctic)
2. <i>Formica sanguinea</i> Latreille, 1798	2000-2900 M	(Palaearctic)
3. <i>Formica gagates</i> Latreille, 1798	2300-3500 M	(France, Poland, Himalayas)
4. <i>Formica rufibarbis rufibarbis</i> Fabricius, 1793	2200 M	(France, China, Himalayas)
<i>Cataglyphis</i> Foerster		
1. <i>Cataglyphis cugiai</i> Menozzi, 1939	1300-3600 M	(Himalayas)
2. <i>Cataglyphis setipes</i> (Forel, 1894)	250-2400 M	(India, Kirghizia)
<i>Camponotus</i> Mayr		
1. <i>Camponotus parius</i> Emery, 1889	up to 1000 M	(Indo-Malaya)
2. <i>Camponotus wasmannii wasmannii</i> Emery, 1893	up to 1200 M	(Indo-Malaya)
3. <i>Camponotus buddhae</i> Forel, 1892	3100-3400 M	(Himalayas, Russia)
4. <i>Camponotus socrates</i> Forel, 1904	1828 M	(Himalayas)
5. <i>Camponotus sylvaticus basalis</i> (Smith, F., 1878)	1700-3000 M	(Himalayas)
6. <i>Camponotus himalayanus</i> Forel, 1893	3000 M	(Himalayas)
7. <i>Camponotus wroughtonii</i> Forel, 1893	2743 M	(Himalayas)
8. <i>Camponotus dolendus</i> Forel, 1892	1500-1830 M	(Himalayas)
9. <i>Camponotus barbatus taylori</i> Forel, 1892	2000 M	(Indo-Malaya)
10. <i>Camponotus albosparsus</i> Bingham, 1903	2000 M	(India, Japan)
11. <i>Camponotus lamareckii</i> Forel, 1892	1000 M	(Himalayas)
12. <i>Camponotus siemsseni</i> Forel, 1901	1200 M	(Himalayas, Sumatra)
13. <i>Camponotus compressus compressus</i> (Fabricius, 1787)	250-2300 M	(India, Phillipines, China)
14. <i>Camponotus rufoglaucus</i> (Jerdon, 1851)	1000 M	(Indo-Malaya)
15. <i>Camponotus sylvaticus pardichrous</i> Emery, 1925	2000 M	(Himalayas)
16. <i>Camponotus kattensis</i> Bingham, 1903	1828 M	(Himalayas)
17. <i>Camponotus aethiops cachmiriensis</i> Emery, 1925	2400 M	(Kashmir, Himalayas)
<i>Paratrechina</i> Motschoulsky		
1. <i>Paratrechina aseta</i> (Forel, 1902)	2438 M	(Himalayas)
2. <i>Paratrechina longicornis</i> (Latreille, 1802)	up to 1500M	(Neotropical, Indo-Malaya)
3. <i>Paratrechina indica</i> (Forel, 1894)	1700-3500 M	(India)
<i>Polyrhachis</i> Smith		
1. <i>Polyrhachis dives dives</i> Smith, F. 1857	1200 M	(Indo-Malaya)
2. <i>Polyrhachis illaudata (mayri)</i> Walker, 1859	830-1200 M	(Indo-Malaya)
3. <i>Polyrhachis menelas</i> Forel, 1904	2100 M	(Himalayas)

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

Species	Range	Locality
4. <i>Polyrhachis striata</i> Mayr, 1862	1524 M	(Indo-Malaya)
5. <i>Polyrhachis lacteipennis (simplex)</i> Smith, F., 1858	250-1900 M	(Indo-Malaya)
6. <i>Polyrhachis tubericeps</i> Forel, 1893	2000 M	(India)
<i>Prenolepis</i> Mayr		
1. <i>Prenolepis naoroji</i> Forel, 1902	830-1900 M	(India)
<i>Pseudolasius</i> Emery		
1. <i>Pseudolasius sp.</i>	1200 M	(Himalayas)
Dolichoderinae		
<i>Dolichoderus</i> Lund		
1. <i>Dolichoderus affinus var. glabripes</i> Forel, 1895	1000 M	(Himalayas)
2. <i>Dolichoderus moggridgei moggridgei</i> Forel, 1886	1000 M	(India)
<i>Bothriomyrmex</i> Emery		
1. <i>Bothriomyrmex wroughtonii r. dalyi</i> Forel, 1895	250- 2900 M	(India)
<i>Tapinoma</i> Foerster		
1. <i>Tapinoma wroughtonii</i> Forel, 1904	2000-2700 M	(Himalayas)
2. <i>Tapinoma melanocephalum melanocephalum</i> (Fabricius,1793)	0-2800M	(Neotropical & Malagasy)
3. <i>Tapinoma indicum indicum</i> Forel,1895	1230 M	(Indo-Malaya)
<i>Chronoxenus</i> (Forel)		
1. <i>Chronoxenus myops</i> (Forel, 1895)	1775 M	(India)
<i>Technomyrmex</i> Mayr		
1. <i>Technomyrmex brunneus</i> Forel, 1895	1700 M	(Oriental, China, Japan)
Dorylinae		
<i>Dorylus</i> Fabricius		
1. <i>Dorylus orientalis orientalis</i> Westwood, 1835	120-2300 M	(India)
2. <i>Dorylus labiatus</i> Schuckard, 1840	250-1200 M	(India & Nepal)
Aenictinae		
<i>Aenictus</i> Schuckard		
1. <i>Aenictus ambiguus</i> Schuckard, 1840	1000 M	(India)
2. <i>Aenictus ceylonicus</i> (Mayr, 1866)	up to 1430 M	(Indo-Malaya)
3. <i>Aenictus doryloides</i> Wilson, 1964	up to 1400 M	(Himalayas)
4. <i>Aenictus fergusonii</i> Forel,1901	900-2400 M	(Indo-Malaya)
5. <i>Aenictus pachycerus pachycerus</i> (Smith, F., 1858)	250-2200 M	(Indo-Malaya)
6. <i>Aenictus sagei</i> Forel, 1901	up to 1500 M	(India)
7. <i>Aenictus aratus (aikenii)</i> Forel, 1900	1400 M	(Himalayas)
8. <i>Aenictus piercei</i> Wheeler and Chapman, 1930	up to 1400 M	(India, Philippines)
Pseudomyrmecinae		
<i>Tetraponera</i> (Smith)		
1. <i>Tetraponera allaborans</i> (Walker, 1859)	75-1450 M	(Indo-Malaya)
2. <i>Tetraponera rufonigra</i> (Jerdon, 1851)	100-1000 M	(Indo-Malaya)
Doubtful taxa		
<i>Platythyrea sagei</i> Forel,1900		
<i>Camponotus nicobarensis</i> Mayr,1865		
<i>Camponotus oblongus oblongus</i> (Smith, F., 1858)		
<i>Camponotus singularis singularis</i> (Smith, F.,1858)		
<i>Polyrhachis punctillata smythiesii</i> Forel,1895		
<i>Paratrechina smythiesii</i> Forel,1894		

Table 1. List of taxa from the Himalayan regions which reach up to or cross an altitude of 1000 M above mean sea level (continued).

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Doubtful taxa

*Lophomyrmex quadrispinosus* (Jerdon, 1851)

*Crematogaster subdentata kaschgariensis* Forel, 1901

*Leptothorax acervorum* (Fabricius, 1793)

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of the total species catalogued; Indian elements, 14.35%; others, 17.8%. The number of endemic or Himalayan elements accounts for a larger percentage than any other group, 45.54%. In summary:

1. Number of subfamilies reaching up to or crossing 1000 meters above sea level: 8
2. Number of genera: 43
3. Number of species: 202
4. Number of Indo-Malayan elements penetrating this region: 45 (22.27%)
5. Number of Indian elements penetrating this region: 29 (14.35%)
6. Number of endemic or Himalayan elements: 92 (45.54%)
7. Others: 36 (17.8%)
8. Genera with maximum number of endemic species : *Myrmica*, *Lasius*, *Aphaenogaster* and *Temnothorax*
9. Most speciose subfamily: Myrmicinae followed by Formicinae.

Out of these 202 species, 115 penetrate into the Palaearctic zone (whose boundary in Southern Asia is largely altitudinal, where an altitude of 2000-2500 meters above mean sea level forms the boundary between Palaearctic and Indo-Malayan ecozones) of the Himalayan region (Map 2). 71 species out of these 115 (61.7%) are endemic to the Himalayas. According to current estimates (Moreau *et al.* 2006) most of the genera or their ancestral lineages originated earlier than the Himalayas. Among these, as stated earlier, *Myrmica* is the dominant genus in terms of endemism and number of species. The Himalayan *Myrmica* fauna is considered to be one of the oldest and most diverse with many of the primitive forms having plesiomorphic features concentrated in this region (Bolton 2003; Radchenko & Elmes 2001; Radchenko, Dlussky & Elmes 2007 and Elmes, G.W. personal communication, email dated 7th April, 2008). The degree of endemism is attributed to the fact that these forms were isolated from the rest of the *Myrmica* fauna at some time in the

late Miocene or early Pliocene (Radchenko, Dlussky & Elmes 2007). The Himalayan ranges were likely invaded by different elements after their formation which showed varying degrees of adaptations to cold climates and started exploiting unused resources/niches. It still remains unclear how the speciation events proceeded in this region and what factors were responsible for them. Whether the speciation patterns and rates which operated in this region and generated such high endemism are the same which we envisage for other groups of animals is an important question for evolutionary biologists to address in the future (Bharti 2008a).

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