Rec. zool. Surv. India : **100** (Part 1–2) : 145–169, 2002

CONTRIBUTION TO THE KNOWLEDGE OF ANTS (HYMENOPTERA : FORMICIDAE) OF CHANDAKA-DAMPARA WILDLIFE SANCTUARY, ORISSA

R. N. TIWARI AND S. K. TIWARI
Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053

INTRODUCTION

Ants have greater degree of adaptability, which has ensured their survival since Oligocene period. They range from pests to predators. Besides this, they have also been utilized as a source of biological control to check the menance of agricultural pests, for example, *Oecophylla smaragdina* (Fab.) against control of citrus fruit, *Solenopsis germinata* (Fab.) on natural enemiesof lac insects and *Camponotus sericeus* (Fab.) found very effective in control of cutworms in lawns.

In terrestrial ecosystem, ants biomass and energy consumption is greater than all the vertebrate fauna taken together (Wilson, 1990) and hence, they have got direct impact on terrestrial ecosystem. "Ants can be seen to dominate ecosystems in a way unequated by any other organism. In addition to their sheer biomass, greater degree of mutualistic ant-plant associations have been observed, which ensure the survival of many plant species, and ant mosaics have been noticed in which dominant ant species cannot only affect and control the distruction of non-dominant ant species, but also influence both the species composition and abundance of other arthropods" (LaSalle and Gauld, 1993).

Present work deals with the study of ants, collected from Chandaka-Dampara Wildlife Sanctuary. The entire collection was made by the second author, during his research work on elephants in Chandaka during the period 1995-1999. Ants particularly attracted the attention of the collector while making observation of elephants dung, leaf litters, bark left over by elephants while feeding in the forest area. The ants were found devouring on cow and elephant dungs, carrying undigested food particles from the dung to their nests. While studying the feeding behaviour of elephants, the author noticed how carefully the elephants avoided the ants while eating the twigs and barks of the plants, by forceful shaking of the plant's parts or blowing of air through the nostril of the trunk. The collection was made from various spots, frequently visited by elephants and some other localities of the Sanctuary during tracking for elephants by the second author during his study period.

After thorough literature consulation and enquiry of Official records, it was found that no list of this social insect from the Sanctuary is available till date. Besides this, efforts were also made to make biological observations of these ants while collecting. This is the first attempt by the authors to contribute towards ants fauna of the Sanctuary.

Altogether 29 species under 15 genera spread over 4 subfamilies have been reported in this paper from Chandaka-Dampara Wildlife Sanctuary, Orissa. All the 29 species are recorded here for the first time from the Sanctuary.

History of work on Indian ants

Rothney (1889, '90, 1903) worked on Indian ants and later on Forel (1885, '86, '90, '92, '93a, '93b, '94, '95, 1900a, 1900b, 1901, 1902a, 1902b, 1903a, 1903b, 1913) contributed comprehensive work on Formicidae of India and Ceylon. Bingham (1903) published his valuable work in *Fauna of British India,* Hymenoptera, Vol. **2**, including Burma and Ceylon and gave details about distribution of species included.

Successive workers like Ali (1981), Brown Jr. (1954a, '54b, '54c, '57, '59, '86, '88), Bolton (1977, '95a, '95b), Baroni Urbani (1973, '77a, '77b, '77c), Chapman and Capco (1951), Chhotani and Maity (1970), Collingwood (1970, '82), Dutta and Raychaudhuri (1983), Devi and Singh (1987), Donisthorpe (1930, '33, '42a, '42b, '42c, '43), Gadagkar *et al.* (1993), Ghosh (1999), Imai *et al.* (1984), Jerdon (1851, '54, '65a, '65b), Kugler (1987), Kurian (1955), Karavaiev (1926, '27, '28), Mathew (1980, '83, '84), Mathew and Tiwari (2000), Reddy *et al.* (1981a, '81b), Roonwal (1954, '75), Ramdas *et al.* (1961), Saunders (1842), Smith, F. (1852, '71a, '71b, '73, '75, '78), Smith, M. R. (1949), Sykes (1835), Sheela and Narendran (1997, '98a, '98b), Shivashankar (1985), Sheela, Narendran and Tiwari (2000), Taylor (1965, 68), Tiwari (1977a, '77c, '86a, '86b, '94, '96, '97, '99a, '99b, 2001a, 2001b), Verghese *et al.* (1981), Veeresh *et al.* (1990) and Wilson (1964).

Bingham (1903) recorded 12 species under 10 genera from Orissa. No comprehensive work on ants fauna of Orissa has been done since then, except a few scattered work.

Study area

Chandaka-Dampara Wildlife Sanctuary, situated in Khurdha and Cuttack district of Orissa lies between the new capital Bhubaneswar and old capital Cuttack, covering an area of 193.39 sq. km. It lies between 20° 16' 05" to 20° 26' 03" N and 85° 34' 42" to 85° 49' 30" E. It is very close (25 km north west) to the capital city of Bhubaneswar in Orissa and can be approached by road via Khandagiri (Fig. 1).

Topography

The terrain is generally undulating which is broken by small low hills. North-western and South-western portions of the reserve are generally hilly with moderate to steep slopes, whereas

the mid-eastern portion is mostly gentle to moderately sloppy with abrupt steep slopes at places. North-eastern and Central portions are relatively flat with little undulation. The altitude varies and is 42 m at Chandaka, 46 m at Dampara, 100 m at Nuakua and 217 m at Pandari mundia (the highest peak in the reserve) above mean sea level (Mishra and Sarangi, 1984).

Climate

Chandaka has a sub-tropical climate. Temperature, relative humidity and rainfall are the three important parameters that have been recorded from 1995 to 1998.

Temperature

The average maximum temperature recorded was during May, being around 37.1°C in Godibari and around 35.5°C in Kumarkhunti. The maximum temperature recroded was 45.9°C in May, 1998.

The average minimum temperature is around December-January being 14°C in the core area and 16°C in Godibari. The absolute minimum temperature recorded in the core area was 8.5°C in 1997 and 12°C in 1996. The temperature thus varies between 10°C to 45°C.

Humidity

The average relative humidity of the study area is generally very high. The maximum average relative humidity is between 80-90% during July-September. The average minimum relative humidity is around 50-60% during December-February.

Rainfall

The state of Orissa is the point of convergence of monsoon currents of the Bay of Bengal and the Arabian Sea. Here the monsoon is brought about by the Southwesterly wind, commonly called the SW-monsoon in summer months and to a little extent by northeasterly wind called the NE-monsoon.

The rainy season in the study area generally starts from mid June. The rain bearing SW-monsoon reaches its peak in the month of August. The average rainfall between June to September was recorded to be 40 cm. Northeast rain is also recorded in this area during October-November. Average rainfall per month during this period was 80 cm in 1998.

The average annual rainfall recorded in this area was 97.76 cm, 108 cm, 190.7 cm and 195.7 cm between 1995-1998.

Vegetation

The vegetation of Chandaka is of the semi evergreen type according to Champion and Seth's classification (1968). But due to severe biotic pressure, edaphic factors and relative humidity, the

existing vegetation has lost its original characters (Choudhury, 1975; Panda, 1992; Roy *et al.,* 1992; Biswal, 1993; Swain, 2000). The Sanctuary is presently covered mostly by bushy/shrubby vegetation. Woodlands are present in mostly coppice growth form. Based on species composition, the forest is classified into following types :

1) Semi evergreen forest dominated by *Xylia xylocarpa.*
2) Dry mixed deciduous forest
3) Bamboo brakes.

MATERIAL AND METHODS

Ants were mostly collected by hand picking with fine forceps and with the help of aspirator. They were also collected by sweeping method with the help of insect nets along with other insects from foliage of bushes. Ants were also collected by using bates in the form of sugar granules, jaggery and rotten mutton placed near ants nests.

Specimens were mostly preserved in 70% alcohol in glass vials. Larger specimens were preserved in insect envelops with preservatives. Observations were made in field where ants were found moving on the soil surface, twings and foliages and biological notes made that of.

The specimens were relaxed and setting and pinning done in laboratory of Zoological Survey of India, Kolkata. The larger ants were directly pinned through the thorax and smaller were mounted on triangular paper boards with the help of water soluble adhesives.

Identification of ants are mainly based on worker caste. During study, mandibles and mouth parts were dissected for specific identification.

SYSTEMATIC ACCOUNT

Ants belonging to family Formicidae of Order Hymenoptera are widely distributed through out the world, because of its cosmopolitan nature, 9538 species of ants under 11 subfamilies, 59 tribes and 296 genera have been reported till date from the world (Hölldobler and Wilson, 1990), of these althogether 2479 species have been reported from the classical Oriental regions, which includes Oriental and Indo-Australian regions. The splitted species 770 are recorded from Oriental region and 1709 from Indo-Australian region (Bolton, 1995a). Approximately 600 species of ants have been reported from India.

LIST OF TAXA INCORPORATED IN SYSTEMATIC ACCOUNT

Family FORMICIDAE

I. Subfamily DORYLINAE Forel

1. Genus ***Dorylus*** Fabricius, 1793

Subgenus ***Typhlopone*** Westwood

1. *Dorylus (Typhlopone) labiatus* Schuckard, 1840

Subgenus ***Alaopone*** Emery, 1881

2. *Dorylus (Alaopone) orientalis* Westwood, 1835

II. Subfamily PONERINAE Lepeletier

2. Genus ***Diacamma*** Mayr, 1862

3. *Diacamma rugosum* (Le Guillou)

3. Genus ***Leptogenys*** Roges, 1861

4. *Leptogenys processionalis* (Jerdon, 1851)

5. *Leptogenys chinensis* Mayr, 1870

4. Genus ***Pachycondyla*** Smith F., 1858

6. *Pachycondyla rufipes* (Jerdon, 1851)

7. *Pachycondyla sulcata* (Frauenfeld, 1867)

III. Subfamily PSEUDOMYRMECINAE Emery

5. Genus ***Tetraponera*** Smith, 1852

8. *Tetraponera allaborans* Walker, 1859

9. *Tetraponera rufonigra* (Jerdon, 1851)

IV. Subfamily MYRMICINAE Lepeletier

6. Genus ***Pheidole*** Westwood, 1841

Subgenus ***Pheidole*** s. str.

10. *Pheidole spathifera* Forel, 1902

11. *Pheidole sulcaticeps* Roger, 1863

7. Genus ***Myrmicaria*** Saunders, 1841

12. *Myrmicaria brunnea* Saunders, 1841

8. Genus ***Crematogaster*** Lund, 1831

13. *Crematogaster politula* Forel, 1902
14. *Crematogaster rothneyi* Mayr, 1878

9. Genus ***Monomorium*** Mayr, 1855

15. *Monomorium floricola* (Jerdon, 1851)
16. *Monomorium latinode* Mayr, 1872
17. *Monomorium scabriceps* (Mayr, 1878)

10. Genus ***Solenopsis*** Westwood, 1841

18. *Solenopsis geminata* (Fabricius, 1804)

11. Genus ***Lophomyrmex*** Emery, 1892

19. *Lophomyrmex quadrispinosus* (Jerdon, 1851)

12. Genus ***Meranoplus*** Smith, 1854

20. *Meranoplus bicolor* (Guérin, 1838)

V. Subfamily FORMICINAE Lepeletier

13. Genus ***Oecophylla*** Smith, 1861

21. *Oecophylla smaragdina* (Fabricius, 1775)

14. Genus ***Paratrechina*** Motschoulsky, 1863

22. *Paratrechina longicornis* (Latreille, 1802)

15. Genus ***Camponotus*** Mayr, 1861

23. *Camponotus angusticollis* (Jerdon, 1851)
24. *Camponotus compressus* (Fabricius, 1787)
25. *Camponotus invidus* Forel, 1802
26. *Camponotus rufoglaucus* (Jerdon, 1851)
27. *Camponotus sericeus* (Fabricius, 1789)

16. Genus ***Polyrhachis*** Smith, 1858

28. *Polyrhachis dives* Smith, 1857
29. *Polyrhachis illaudata* Walker, 1859

SYSTEMATIC ACCOUNT

Subfamily DORYLINAE Forel

1. Genus *Dorylus* Fabricius

1793. *Dorylus* Fabricius, *Ent. Syst.*, **2** : 194.

Type-species : *Vespa helvola* ♂ (Linnaeus, 1764) from South Africa.

Subgenus *Typhlopone*

1839. Typhlopone Westwood, *Introd. Classif. Ins.*, **2** : 219.

Type species : *Typhlopone fulva* Westwood, 1839 from North Africa.

1. *Dorylus (Typhlopone) labiatus* Shuckard

1840. *Dorylus labiatus* Shuckard, *Ann. Mag. Nat. Hist.*, **5** : 319, M.

1995. *Dorylus (Typhlopone) labiatus,* Bolton, *A New Genl. Cat. Ants World,* Harvard Univ. Press, : 179.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 6 workers, Ambakhali, 2.i.1996, 4 workers, Nuakua, 17.vii.1997.

Distribution : INDIA : Orissa and whole of continent of India, particularly from Sikkim, Manipur, West Bengal, Uttar Pradesh, Himachal Pradesh, Maharashtra, Gujarat and Delhi.

Remarks : These ants are golden yellow in colour with strong mandibles and are found hovering on dead animals. They are carnivorous in nature. These specimens were collected near Ambakhali feeding on Lepidopteran larvae.

Subgenus *Alaopone* Emery

1881. *Alaopone* Emery, *Ann. Mus. Civ. Stor. Nat. Genova,* **16** : 274.

Type species : *Dorylus (Alaopone) orientalis* Westweed, 1835 = *(Alaopone oberthueri* Emery, 1881) from India.

2. *Dorylus (Alaopone) orientalis* Westwood

1835. *Dorylus orientalis* Westwood, *Proc. Zool. Soc. Lond.*, **3** : 72, Male

1999. *Dorylus (Alaopone) orientalis,* Tiwari, *Memoir, Zool. Surv. India,* **18**(4) : 16

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 5 workers, at Godibar, 9.ii.1996, 1worker, Kochilaberna, 11.vii.1997, ex. Banana root.

Distribution : INDIA : Orissa, Kerala, Maharashtra, West Bengal. Elsewhere : Burma, China, Malayan Peninsula, Indonesia (Java, Sumatra, Borneo), Nepal, Sri Lanka.

Remarks : This species is commonly known as root eating ant, the workers feed on soft parts of root and the tuberous roots are hollowed out.

Green (1903) also agreed with above vegetation behaviour of the said species, but Mukherjee (1933), doubted this. He studied the worker's mouth parts in detail and found them "better adapted for feeding on animal food than on plants. The sharp pointed bristle, spines and setae on the 1st/ 2nd maxillae, can well pierce the skin of the victim and draw out the nutritive fluid from the body of their prey, which they suck by their mobile tongue"

3. Genus ***Diacamma*** Mayr

1862. *Diacamma* Mayr, *Verh .zool-bot. Ges. Wien,* **12** : 718, worker.

Type-species : *Ponera rugosa* Le Guillou, 1841 from Borneo (Indonesia).

3. Diacamma rugosum (Le Guillou)

1842. *Ponera rugosa* Le Guillou, *Ann. Soc. Ent. Fr.,* **10** : 318

1995. *Diacamma rugosum,* Bolton, *A new Genl. Cat. Ants World,* Harvard Univ. Press, : 170.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 4 Workers, 1 km from Kochilaberna tower towards Ambakhali, 22.vi.1997; 2 workers near Ambilo tower, 11.ix.1998; 3 exs. from Dahanagadia village, 4.vii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Karnataka, Maharashtra, West Bengal, Meghalaya, Sikkim, Assam, Andaman and Nicobar Islands. Elsewhere : Myanmar, Sri lanka, Malaysia, Singapore, Phillippines, Vietnam, Taiwan, New Guinea, Batchian Is (Pacific), Nepal.

Remarks : It nests in the soil at the base of trees (Seeson, 1941). In Chandaka, it was collected from mango tree, may be the specimens were ascending on the tree for search of mango fruits. This species is known by a number of subspecies (Bolton, 1995).

4. Genus ***Leptogenys*** Roger

1861. *Leptogenys* Roger, *Berl. ent. Zeitschr.,* **5** : 41, worker.

Type-species : *Leptogenys falcigera* Roger, 1861 from Sri Lanka (formerly Ceylon).

4. Leptogenys processionalis (Jerdon)

1851. *Ponera processionalis* Jerdon, Madras, *J. Lit..Sic.,* **17** : 118

1995. *Leptogenys processionalis,* Bolton, *A New Genl. Cat. Ants World,* Harvard Univ. Press., : 233.

1999. *Leptogenys (Lobopelta) ocellifera,* Tiwari, *Memoirs Zool. Surv. India,* **18**(4) : 22

Material examined : India: Orissa:, Chandaka-Dampara Wildlife Sanctuary : several workers on southeast slopes of Ambilo tower, 30.v.1998; 7 workers at Kodalimundia 28.xii.1998 on leaf litter.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, West Bengal, Meghalaya and nearly whole of Peninsular India. Elsewhere : Sri Lanka.

Remarks : The second author while moving near Ambilo tower noticed a long que of ants moving very fast in zig zag manner making a procession of ants, carrying the eggs in their mouth, most probably taking the eggs to some safer place.

Tiwari (1995) reported this species as *Leptogenys (Lobopelta) ocellifera* (Roger, 1861) but Emery (1913) has synonomised this species under *Leptogenys processionalis* (Jerdon) which was supported by Bolton (1995b).

5. Leptogenys chinensis Mayr

1870. *Lobopelta chinensis* Mayr, *Verh. zool-bot. Ges. Wein,* **20** : 965.

1995. *Leptogenys chinensis,* Bolton, *A New Genl Cat Ants World,* Harvard Univ. Press, : 230

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 2 workers, near Kheluachua, 16.xi.1997.

Distribution : INDIA : Orissa, West Bengal, more or less whole India, except drier part of Central India and Western India. Elsewhere : China, Japan, Philippines, Sri Lanka.

5. Genus ***Pachycondyla*** Smith

1858. *Pachycondyla* Smith, *Cat. Hym. Brit. Mus.,* **6** : 105.

Type-species : *Formica crassinoda* Latreille, 1802 from Surinam (S. America).

6. Pachycondyla rufipes (Jerdon)

1851. *Ponera rufipes* Jerdon, *Madras J. Lit. Sci.,* **17** : 119, worker

1995. *Pachycondyla rufipes,* Bolton, *A. new. Genl. Cat. Ants World,* Harvard Univ. Press, : 309.

Material examined : India : Orissa, Chandaka-Dampara Wildlife Sanctuary, 3 exs, near Godabhangatangaro, 2.i.1997, under wood logs.

Distribution : INDIA : Orissa, Sikkim, Assam, Meghalaya, West Bengal, Western India, Karnataka, Kerala, Andaman and Nicobar Islands. Elsewhere : Sri Lanka, Myanmar.

Remarks : This ant is a robust ponerine ant and while being picked up for collection, was found to emit a thick white frothy fluid from their mouth, of very offensive nature containing formic acid smell—which seems to be a defensive mechanism.

7. Pachycondyle sulcata (Frauenfeld)

1867. *Ponera sulcata* Frauenfeld, *Verh. zool-bot. Ges. Wein,* **17** : 441.

1995. *Pachycondyla sulcata,* Bolton, *A new Genl. Cat. Ants World,* Harvard Univ. Press, : 310.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 4 workers, Dampara, 13.viii.1995, from rotten wood.

Distribution : INDIA Orissa, Andhra Pradesh, Tamil Nadu, West Bengal, Central and Western India.

Subfamily PSEUDOMYRMECINAE Emery

5. Genus ***Tetraponera*** Smith

1852 *Tetraponera* Smith, *Ann. Mag. Nat. Hist.*, **9**(2) : 44.

Type-species : *Eciton nigrum* Jerdon, 1851 (= *Tetraponera atrata* Smith, 1852) from India.

8. Tetraponera allaborans Walker

1859. *Pseudomyrma allaborans* Walker, *Ann. Mag. Nat. Hist.*, **4**(3) : 375, Male.

1999. *Tetraponera (Tetraponera) allaborans,* Tiwari, *Memoirs Zool. Surv. India,* **18**(4) : 34.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 3 workders, Minchinpatna, 21.ix.1998; 2 workers, Nuakua, 21.ix.1998, ex.twigs of bushy plants.

Distribution : INDIA : Orissa, Tamil Nadu, West Bengal, Meghalaya, Western India. Elsewhere : Sri Lanka, Myanmar, Indonesia (Sumatra), Kalimantan, China.

Remarks : These ants are black, highly polished and shinning with metallic blackish colour and were found moving in scattered forms at bushy plant of *Eupatorium odonatum.* The stings were protruded and situated at the tip of last gaster segment.

9. Tetraponera rufonigra (Jerdon)

1851. *Eciton rufonigram* Jerdon, *Madras J. Lit. Sci.* **17** : 111, Worker.

1999. *Tetraponera (Tetraponera) rufonigra,* Tiwari, *Memoirs Zool. Surv. India* **18**(4) : 35.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Godibaru gate, 9.xii, 1995, ex. Trunk of Sal tree; 6 workers, Chatiani, 11.xi.1997, ex. heeps of twigs of plants left over by elephant.

Distribution INDIA Orissa, Tamil Nadu, Karnataka, Kerala, Meghalaya and most widely distributed species in India. Elsewhere : Myanmar, Sri Lanka, Singapore, Indonesia (Java, Sumatra), China.

Remarks : This species is most virulent, its sting is most painful and causes considerable inflammation (Bingham, 1903).

Subfamily MYRMICINAE Lepeletier

6. Genus *Pheidole* Westwood

1841. *Pheidole* Westwood, *Ann. Mag. Nat. Hist.*, **6** : 87.

Type-species : *Atta providens* Sykes, 1835 from India.

10. Pheidole spathifera Forel

1902. *Pheidole spathifera* Forel, *Rev. Suisse. Zool,* **10** : 168 & 187, soldier, worker, female and male.

1999. *Pheidole (Pheidole) spathifera,* Tiwari, *Memoirs Zool. Surv. India,* **18** (4) : 39.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Dholkat village, 11.ii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Andhra Pradesh, Kerala, Western India (the Nilgiris), Assam, West Bengal. Elsewhere : Sri Lanka, Myanmar.

11. Pheidole sulcaticeps Roger

1863. *Pheidole sulcaticeps* Roger, *Berl. ent. Zeit.*, **7** : 193, Soldier.

1995. *Pheidole sulcaticeps,* Bolton, *New Genl. Cat. Ants world,* Harvard Univ. Press, : 331

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 5 Workers, Bualigarh, 6.vii.1998.

Distribution : INDIA : Orissa : West Bengal, North-west provinces and western India. Elsewhere : Sri Lanka

7. Genus *Myrmicaria* Saunders

1841. *Myrmicaria brunnea* Saunders, *Trans. Ent. Soc. Lond.*, **3** : 57, Male.

Type-species : *Myrmicaria brunnea* Saunders, 1841 from India.

12. *Myrmicaria brunnea* Saunders

1841. *Myrmicaria brunnea* Saunders, *Trans. Ent. Soc. Lond.* **3** : 57, Male.

1999. *Myrmicaria brunnea,* Tiwari, *Memoirs Zool. Surv. India* **18** (4) : 41-42.

Material examined : India : Orissa : Chandaka-dampara Wildlife Sanctuary : 3 workers, Kumarkhunti tower, 8.vi.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Meghalaya, West Bengal, and throughout India except drier and more desert parts of the country. Elsewhere : Myanmar, Sri Lanka, Indonesia (Java, Sumatra), Indo-China.

8. Genus *Crematogaster* Lund

1831. *Crematogaster* Lund. *Ann. Sci. Nat.*, **23** : 132.

Type-species : *Formica scutellaris* Olivier, 1791 from France.

13. *Crematogaster politula* Forel

1902. *Crematogaster subnuda* Mayr, 1879, race *politula* Forel, *Rev. Suisse Zool.*, **10** : 207.

2000. *Crematogaster politule* Mathew and Tiwari, *State Fauna Series* **4**, *Fauna of Meghalaya* Part 7 : 326.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Kodalinundia, 7.iii.1997.

Distribution INDIA : Orissa, Meghalaya, Assam, Sikkim. Elsewhere : Myanmar.

Remarks : Datta and Raychaudhuri (1983) reported this species as one of the aphidoculous ants from Sikkim.

14. *Crematogaster rothneyi* Mayr

1879. *Crematogaster rothneyi* Mayr, *Verh. zool-. bot. Ges. Wien*, **28** : 681 & 685, Female.

2000. *Crematogaster rothneyi*, Mathew and Tiwari, *State Fauna series 4, Fauna of Meghalaya, Part 7* : 327.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 11 workers, Guptapara, 11.ii.1996.

Distribution : INDIA : Orissa, Meghalaya, Maharashtra, Sikkim, West Bengal, Gujarat and Tamil Nadu.

9. Genus *Monomorium* Mayr

1855. Monomorium Mayr, *Verb. zool-bot. Ges. Wein*, **5** : 452.

Type-species : *Formica pharaonis* Linnaeus, 1758 (= *Monomorium minutum* Mayr, 1855) from Egypt.

15. *Monomorium floricola* (Jerdon)

1851. *Atta floricola, Madras J. Lit. Sci.*, **17** : 107, Worker.

1999. *Monomorium floricola*, Tiwari, *Memoirs. Zool. Surv. India*, **18** (4) : 54.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 8 workers, Ambilo tower, 7.v.1996.

Distribution INDIA : Orissa, Tamil Nadu, Kerala, West Bengal, Meghalaya, Manipur, Andaman and Nicobar Islands. Elsewhere : Sri Lanka, Oceania.

Remarks : This is a common house ant in India and is found damaging food stuffs.

16. ***Monomorium latinode*** Mayr

1872. *Monomorium latinode* Mayr, *Ann. Mus. Civ. Stor. Nat. Genova,* **2** : 152, worker.

1999. *Monomorium latinode,* Tiwari, *Memoirs Zool. Surv. India,* **18** (4) : 54.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Nuakua, 2.viii.1996; 6 workers, Kheluachua, 11.ix.1998.

Distribution : INDIA : Orissa, Tamil Nadu, West Bengal and spread throughout India. Elsewhere : Sri Lanka, Myanmar, Indonesia (Borneo), Formosa (Taiwan).

Remarks : Bingham (1903) mentioned its distribution throughout India. Howevere, Ettershank (1966) has restricted the distribution of *latinode* to Borneo only.

17. ***Monomorium scabriceps*** Mayr

1879. *Holcomyrmex scabriceps* Mayr, *Verh. zool-bot. Ges. Wien,* **28** : 672, Worker.

1995. *Monomorium scabriceps,* Bolton, *A New Genl. Cat. Ants World,* Harvard Univ. Press, : 266.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 4 workers, Godibari, 11.ix.1996; 3 workers Baramundia, 7.viii.1998.

Distribution : INDIA : Orissa, distributed irregularly throughout India from Pubjab to Cochin.

Remarks : This is the first record of this specis from the state of Orissa.

10. Genus ***Solenopsis*** Westwood

1841. *Solenopsis* Westwood, *Ann. Mag. Nat. Hist.,* **6** : 86.

Type-species : *Atta geminata* Fabricius, 1804 from Central America (= *Solenopsis mandibularis* Westwood, 1841).

18. ***Solenopsis geminata*** (Fabricius)

1804. *Atta geminata* Fabricius, *Syst. Piez.* : 423.

1999. *Solenopsis geminata,* Tiwari, *Memoirs Zool. Surv. India,* **18** (4) : 58-59.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Dholkat village, 11.viii.1997; 1 worker, Ambilo tower, 11.viii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Karnataka, West Bengal.

Elsewhere : Spread pretty nearly over the tropics of the two hemispheres.

Remarks : This speciemen is collected from resting site of elephants from the soil surface. The elephants were seen blowing air through nostril to remove these ants from the area and this prompted the second author to search for these ants in the resting site.

S. geminata commonly known as "Brown fire ants" has severe sting. It makes its nest on soil surface making tunnel and is reported to be injurious to seedlings, buds and leaves. It is reported to be an important enemy of aphids, soft scales, termites, bed bugs and moth largae and caterpillars of *Eublemma amabilia* and *Holococera pulverea* in the lac godowns (Beeson, 1941).

11. Genus ***Lophomyrmex*** Emery

1892. *Lophomyrmex* Emery, *Ann. Mus. Civ. Stor. Nat. Genova,* **22** : 114.

Type-species : *Ocodoma qudrispinosa* Jerdon, 1851 from Malabar, India.

19. ***Lophomyrmex quadrispinosus*** (Jerdon)

1851. *Ocodoma quadrispinosa* Jerdon, *Madras J. Lit. Sci.,* **17** : 111.

1999. *Lophomyrmex quadrispinosus,* Tiwari, *Memoirs Zool. Surv. India,* **18** (4) : 59.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Godibari, 2.i.1996; 3 workers, Ambakhali, 2.i.1996.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Karnataka, Meghalaya, Uttar Pradesh, Sikkim, West Bengal. Elsewhere : Sri Lanka.

Remarks : Jerdon (1951) reported its feeding behaviour and noted that it feeds on vegatable secretion surrounding the seeds. The author also collected it from flower of *Madhuca indica.*

12. Genus ***Meranoplus*** Smith, 1853

1853. *Meranoplus* Smith, *Trans. Ent. Soc. Lond.,* **2** (2) : 224.

Type-species : *Cryptocerus bicolor* Guérin, 1838 from India.

20. ***Meranoplus bicolor*** (Guérin)

1844. *Cryptocerus bicolor* Guérin, *Cuv. Iconog. Regn. Anim. Ins.,* **3** : 425, Worker.

2000. *Meranoplus bicolor,* Mathew and Tiwari, Zool. Surv. India., *State Fauna Series 4, Fauna of Meghalaya,* Part 7 : 332.

Material examined : India, Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Ambakhali, 7.viii.1996; 2 workers, Dahanagiria, 11.vii.1998.

Distribution : INDIA : Orissa, West Bengal, Assam, Meghalaya, Maharashtra, Uttar Pradesh, Delhi, Karnataka, Kerala, Tamil Nadu and mostly throughout India, except the hot dry plains in the North-Western Provinces and Central India. Elsewhere : Nepal, Myanmar, Sri Lanka, Pakistan, Bhutan, Thailand, Vietnam, China, Singapore, Malaysia, Indonesia (Sumatra) and extending to the Malayan subregion.

Subfamily FORMICINAE Lepeletier

13. Genus ***Oecophylla*** Smith

1861. *Oecophylla* Smith, *J. Proc. Linn. Soc. Lond. Zool.*, **5** : 101, worker, female.

Type-species : *Formica smaragdina* Fabricius, 1775 from India (= *Formica virescens* Fabricius, 1775).

21. ***Oecophylla smaragdina*** (Fabricius)

1775. *Formica smaragdina* Fabricius, *Syst. Ent.*, : 828, Female.

1999. *Oecophylla smaragdina*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4); 66.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 15 workers, Sanchuria mundia, 11.xi.1998

Distribution : INDIA : Orissa, Meghalaya, Tamil Nadu, Karnataka, Kerala, West Bengal Sikkim, Meghalaya, Manipur, Andaman and Nicobar Islands and mostly the whole of India, except desert parts. Elsewhere : Sri Lanka, Myanmar, South China, Malaya, New Guinea, Australia.

Remarks : The specimens of this species were collected from Jackfruit plant. These ants make a specalised type of nest which hang from the twigs of the trees. The nest is made up of leaves which are bound together by fine membranous tissue paper made by the ants by chewing leaves and converting it to sysnthetic tissue.

The eggs of the species have been found to contain high protein and fat and as such, it is used as a supliment to combat the condition of avitaminosis, particularly in case of marasemus condition. It is widely used as a supplement for protein and fat in tribal people and the eggs are sold in weekly market for this purpose.

14. Genus ***Paratrechina*** Motschoulsky 1863

1863. *Paratrechina* Motschoulsky, *Bull. Soc. Imp. Nat. Moscou.*, **36** : 13.

Type-species : *Formica longicornis* Latreille, 1802 from Senegal (= *Paratrechina currens* Motschoulsky, 1863) from Senegal.

22. ***Paratrechina longicornis*** (Latreille)

1802. *Formica longicornis* Latreille, *Nat. Hist. Fourmis*, 113

2000. *Paratrechina longicornis*, Mathew and Tiwari, *Zool, Surv. India, State Fauna Series* **4**, *Fauna of Meghalaya, part 7* : 349.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 1 worker, Ambilo tower, 2.i.1996; 5 workers, Godabhangatangaro, 7.iv.1998.

Distribution : INDIA : Orissa, West Bengal, Meghalaya, manipur, Tamil Nadu and mostly throughout India. Elsewhere : Senegal, Australia, New Caledonia, Sri Lanka.

15. Genus *Camponotus* Mayr

1861. *Camponotus* Mayr. *Europ Formicid.* : 35.

Type-species : *Formica ligniperda* Latreille, 1798 from Europe.

23. *Camponotus compressus* (Fabricius)

1787. *Formica compressa* Fabricius, *Mant. Insect,* **1** : 307, worker

1999. *Camponotus compressus,* Tiwari, *Memoirs Zool, Surv. India,* **18** (4) : 69.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 3 workers, Guptapar, 11.xi.1996; 7 workers, Minchinpatna, 11.xi.1996; 3 workers, Goyalbanka, 12.xii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Assam, Meghalaya, West Bengal, Manipur, Sikkim, Andaman and Nicobar Island. Elsewhere : Sri Lanka, Nepal, Myanmar, Philippines, Borneo, Russia, Arabia and Africa.

Remarks : This is the common black ant, spread all over India, the nests are made in soil and heaps of earth are brought in the form of small files,. Their food is chiefly vegetable secretion and sugar in any form. They bite rather severely but the pain is quite momentary.

24. *Camponotus refoglaucus* (Jerdon)

1851. *Formica rufoglaucus* Jerdon, *Madras J. Lit. Sci.,* **17** : 124.

1999. *Componotus rufoglaucus,* Tiwari, *Memoirs Zool. Surv. India,* **18** (4) : 70.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Ambilo, 15.xii.1996; 12 Workers, Jhalara, 21.viii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Karnataka, Kerala, Delhi, Central India, Assam, Meghalaya, Deccan Plateau. Elsewhere : Nepal, Myanmar and Sri Lanka.

25. *Camponotus sericeus* (Fabricius)

1798. *Formica sericeus* Fabricius, *Ent. Syst. Suppl,* : 97.

2000. *Camponotus sericeus,* Mathew & Tiwari, Zool. Surv. India, *State fauna series* **4**, *Fauna of Meghalaya, part 7* : 356.

Material examined : India Orissa, Chandaka-Dampara Wildlife Sanctuary 5 workers, Dampara, 7.iii.1998.

Distribution INDIA : Orissa, Tamil Nadu, Karnataka, West Bengal, Manipur, Meghalaya, Delhi and more or less common throughout India. Elsewhere : Myanmar, Sri Lanka, Indo-China, Arabia, Egypt and Tropical Africa.

Remarks : This ant is easily differentiated from other species because of basal portion of the metanotum forming a horizontal and flat surface with rest of the metanotum; usually it is black out certain specimens from Myanmar and Ceylone have been reported having head blood-red, a special

variation in colour pattern. Tiwari (1999) while examining the ant fauna of Delhi came across the species with blood-red head.

26. *Camponotus angusticollis* (Jerdon)

1851. *Formica angusticollis* Jerdon, *Madras J. Lit. Sci.*, **17** : 120, Worker, Female.

2000. *Camponotus angusticollis*, Mathew and Tiwari, Zool. Surv. India, *State Fauna Series* **4**, *Fauna of Meghalaya, Part 7* : 352

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers. Dhobabandha, 21.xi.1996; 7 workers, Bualigarh, 7.iii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Western and Central India, Assam, West Bengal, Meghalaya, Andaman and Nicobar Islands. Elsewhere : Nepal, Myanmar.

27. *Camponotus invidus* Forel

1892. *Camponotus invidus* Forel, *J. Bombay Nat. Hist. Soc.*, 7 : 225 and 234, Worker.

1995. *Componotus invidus*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press : 105.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 11 workers, Mincinpatna, 19.v.1997; 8 workers, Dalua, 16.ix.1998.

Distribution : INDIA : Orissa, Sikkim, West Bengal, Andaman and Nicobar Islands.

16. Genus *Polyrhachis* Smith

1858. *Polyrhachis* Smith, *J. Proc. Linn. Soc. Lond. Zool.*, **2** : 58.

1862. *Polyrhachis* Mayr, *Verh. zool-bot. Ges. Wien.*, **12** : 677.

Type-species : *Formica bihamata* Drury, 1773 from Madagascar.

28. *Polyrhachis illaudatus* Walker

1859. *Polyrhacis illaudatus*, Walker, *Ann. Mag. Nat. Hist.*, (3) **4** : 373, Worker.

1995. *Polyrhachis illaudata*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Pressd, : 350.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sancturary : 3 workers, near Pitagadia tower, 6.vi.1997.

Distribution : INDIA : Orissa, Tamilnadu, Kerala, Karnataka, Assam, Sikkim, West Bengal. Elsewhere : Sri Lanka, Nepal, Myanmar, China, Philippines, Formosa, Gulf of Siam, Indnesia (Java, Sumatra, Borneo, Celebes). This distribution is mainly for *P. mayris* synonomised under *P. illaudata*.

Remarks : Donisthorpe (1943) treated *P. mayri* Roger, 1863 as a synonym of *P. illaudata* Walker, 1859 but Collingwood (1970) considered *mayri* as a valid species under *Polyrhachis*. Bolton (1995b) agrees with Donisthorpe (1943). As the authors have no access to type of this species, it is not

possible to give any opinion in this respect. The present specimens come to *mayri* when run through Bingham's key (1903). But as because, the *P. mayri* has been synonymised under *P. illaudata*, the authors treated *P. mayri* as *P. illaudata*.

29. ***Polyrhachis dives*** Smith

1857. *Polyrhachis dives*, Smith, *J. Proc. Linn. Soc. London Zool*, **2** : 64, Worker.

2000. *Polyrhachis dives*, Mathew and Tiwari, *Zool. Surv. India, State Fauna Series 4, Fauna of of Meghalaya, Part 7*, 361.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 1 worker, Jhalara, 8.ii.1998; 3 workers, Ambilo, 8.ii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Sikkim, Meghalaya and Eastern India. Elsewhere : Sri Lanka, Myanmar, Thailand, Indo-China, China, Philippines, Malay, Siam, Formosa, Mainan, Japan, Indonesia (Java, Sumatra, Celebes), New Guinea, Singapore.

SUMMARY

The paper deals with the ants (Hymenoptera : Formicidae) collected from different localities of Chandaka Wildlife Sanctuary, Orissa by second author, during his study period (1995-1998) on the ecology and behaviour of elephants. Altogether 29 species pertaining to 17 genera and 5 subfamilies have been reported. There is no mention of any ant species in forest record of the Sanctuary. Hence, this is the first record of these ants species from this Sanctuary. Besides this, *Monomorium scabriceps* Mayr is the first record from the state of Orissa. A separate map of the Sanctuary showing the localities of collection has been incorporated. Notes on topography and methodology have been provided to deliciate the basic concept of the family.

ACKNOWLEDGEMENTS

The authors are greatly indebted to the Chief Conservator of Forest and Wildlife Warden, Orissa for according permission to carry on this study. A sense of indebtedness is extended to Dr. J. R. B. Alfred, Director, Zoological Survey of India, Calcutta for his assiduous guidance and constant supervision, throughout the course of this investigation. The authors also express their sense of gratitude to Dr. G. K. Srivastava, Addl. Director and Dr. S. K. Mitra, Scientist-SF and in-charge, Entomology division, for taking keen interest in this work. The authors are thankful to Dr. B. G. Kundu, Hymenoptera Section for going through the manuscript and making necessary correction. The authors also extend their thanks to D.F.O., Chandaka-Dampara Wildlife Sanctuary for persistent co-operation during the study period.

REFERENCES

Ali, T. M. M. 1981. Ant fauna (Hymenoptera : Formicidae) of Bangalore with observations on their nesting and foraging habit. M.Sc. Thesis *ISA Bangalore* 208 pp.

Baroni Urbani, C., Stemler, O., Witmer, W., Würmli, M. 1973. Zoologische Expedition des Naturhistorischen Museums Basel in das Konigreich Bhutan. *Verh. Naturforsch. Ges. Basel.* **83** : 319-336.

Baroni Urbani, C. 1977a. Ergebnisse der Bhutan Expedition 1972 des Naturhisttorischem Museum in Basel. Hymenoptera Fam. Formicidae Genus *Mageriella. Entomol. Basil*, **2** : 411-414.

Baroni Urbani, C. 1977b. *Discothyrea stumperi* n. sp. du Bhutan, premier representant du genera dams le subcontinent Indian (Hymenoptera : Formicidae) *Arch. Inst. Grand Ducal Luxemb.* (N.S.), **37** : 97-101.

Baroni Urbani, C. 1977c. Ergebnisse der Bhutan Expedition. 1972 des Naturhistorischen Museum in Basel Hymenoptera : Fam. Formicidae Genus *Stenamma*, Con una nuova species del Kashmir. *Entomol. Basel.* **2** : 415-422.

Baroni Urbani, C. & De Andre, M. L. 1993. *Perisomyrmex monticola* n. sp. from Bhutan : the first natural record for a presumed Neotropical genus with a discussion on its taxonomic status, *Trop. Zool.*, **6** : 89-95.

Bingham, C. T. 1903. *The Fauna of British India, including Ceylon and Burma*. Hymenoptera, Ants and Cuckoo-wasps London : Taylor and Francis, **2** : 1-506.

Biswas, A. K. 1993. Floristic studies in some Sanctuary of Orissa. Unpublished ph.D. thesis. Utkal University, Orissa.

Bolton, B. 1977. The ant tribe Tetramoriini (Hymenoptera : Formicidae). The genus *Tetramorium* Mayr in the oriental and Indo-Australian regions, and in Australia. *Bull. Brit. Mus. (Nat. Hist.) Entomol*, **36** : 67-151.

Bolton, B. 1995a. A taxonomic and zoo-geographical census of the extant and taxa (Hymenoptera Formicidae). *J. Nat. Hist.*, **29** : 1037-1056.

Bolton, B. 1995b. *A new general catalogue of the ants of the world*, Cambridge, Mass : Harvard University Press, **1** : 1-504.

Brown, W. L., Jr. 1954a. The Indo-Australian species of ant genus *Strumigenys* Fr. Smoth S. wallacei Emery and relatives. *Psyche* (camb.), **60** : 85-89.

Brown, W. L., Jr. 1954b. The Indo-Australian species of ant genus *Strumigenys* Fr. Smoth group of *dorae* Emery *Psyche*, **60** : 160-166.

Brown, W. L., Jr. 1954c. The Indo-Australian species of ant genus *Strumigenys* Fr. Smoth : *S. chapmani* new species. *Psyche*, **61** : 68-73.

Brown, W. L., Jr. 1957. The Indo-Australian species of ant genus *Strumigenys* Fr. Smoth : Three new Philippine species. *Psyche*, **63** : 113-118.

Brown, W. L., Jr. 1959. The Indo-Australian species of ant genus *Strumigenys* Fr. Smoth : group of *S. godeffroyi* in Borneo. *Psyche*, **65** : 81-89.

Brown, W. L., Jr. 1986. Indomyrma dsypyx, new genus and species, a myrmicine and from peninsular India (Hymenoptera : Formicidae) *Irs. J. Entomol.*, **19** : 37-49.

Brown, W. L., Jr. 1988. *Neoclystopsenella* (Bethylidae) a synonym of *Tapinoma* (Formicidae) *Psyche*, **94** : 337.

Chapman, J. W. & Capco, S. R. 1951. Checklist of the ants (Hymenoptera : Formicidae) of Asia. *Mongr. Inst. Sci. Tech. Manila*, **1** : 1-327.

Chhotani, O. B. & Maiti, P. K. 1970. Contribution to the knowledge of Formicidae of the Andaman Islands (Abstract) *Proc. Indian. Sci. Congr.*, **57**(3) : 438.

Choudhury, B. P. & Patnaik, S. N. 1975. Flora of Bhubaneswar and adjoining region. *J. Econ. Tax. Bot.*, **3** : 549-555.

Collingwood, C. A. 1970. Formicidae (Hymenoptera : Aculeata) from Nepal. *Khumbu Himal Ergeb. Forschungsunternehm Nepal Himal*, **3** : 371-387.

Collingwood, C. A. 1982. Himalayan ants of genus *Lasius* (Hymenoptera : Formicidae) *Syst. Entomol.*, **7** : 283-296.

Devi, C. M. & Singh, T. K. 1987. Aphidocolous ants (Hymenoptera : Formicidae) in Manipur. *Entomon*, **12**(4) : 309-313.

Donisthorpe, H. 1930. A new species of Acanthomyops (Hymenoptera : Formicidae) from Kashmir. *Ann. Mag. Nat. Hist.*, **10**(6) : 225-226.

Donisthorpe, H. 1933. A new species of *Acanthomyops* (Hymenoptera : Formicidae) from India. *Stylops*, **2** : 24.

Donisthorpe, H. 1942a. Ants from the Colombo Museum Expedition toSouthern India, September-October 1938. *Ann. Mag. Nat. Hist.*, (1)**9** : 449-461.

Donisthorpe, H. 1942b. Ants from the Columbo Museum Expedition to Southern India, Sept.-Oct., 1938. *Ann. Mag. Nat. Hist., London*, (11)**9** : 449-461.

Donisthorpe, H. 1942c. Description ofa few ants from the Philippines Islands and a male of Polyrhachis bihamata Drury from India. *Ann. Mag. Nat. Hist., London,* (11)**9** : 64-72.

Donisthorpe, H. 1943. Ants from the Colombo Museum Expedition to Southern India, Sept.-Oct., 1938. *Ann. Mag. Nat. Hist., London*, (11)**10** : 196-208.

Dutta, S. K. & Raychaudhuri, D. 1983. Taxonomy of aphidocolous ants (Hymenoptera : Formicidae) of Sikkim and hilly areas of West Bengal (1) subfamily : Myrmicinae. *AKITU, N. Ser.*, **56** : 1-14.

Forel, A. 1885. Indian ants of the Indian Museum, Calcutta. *J. Asiat. Soc. Bengal, Part II. Nat. Sci.*, **54** : 176-182.

Forel, A. 1886. Indian ants of the Indian Museum, Calcutta, No. 2, *J. Asiat. Soc. Bengal, Part II. Nat. Sci.*, **55** : 239-249.

Forel, A. 1890. Eine myrmekologische Ferienreise nach Tunesien and Ostolgerien nebst einer Beobachtung des Herm Gleadow in Indian fiber *Aenictus. Humboldt*, **9** : 296-306.

Forel, A. 1892. Les Formicides de l'Empire des Indes et. de Ceylon, Part I, *J. Bomb. Nat. Hist.Soc.*, **7** : 219-245.

Forel, A. 1893a. Les Formicides de l'Empire des Indes et. de Ceylon, Part II, *J. Bomb. Nat. Hist. Soc.*, **7** : 430-439.

Forel, A. 1893b. Les Formicides de l'Empire des Indes et. de Ceylon, Part III, *J. Bomb. Nat. Hist. Soc.*, **8** : 17-36.

Forel, A. 1894. Les Formicides de l'Empire des Indes et. de Ceylon, Part IV, *J. Bomb. Nat. Hist. Soc.*, **8** : 396-420.

Forel, A. 1895. Les Formicides de l'Empire des Indes et. de Ceylon, Part V, *J. Bomb. Nat. Hist. Soc.*, **9** : 453-472.

Forel, A. 1900a. Les Formicides de l'Empire des Indes et. de Ceylon, Part VI, *J. Bomb. Nat. Hist. Soc.*, **13** : 52-65.

Forel, A. 1900b. Forel, A. 1893c. Les Formicides de l'Empire des Indes et. de Ceylon, Part VII, *J. Bomb. Nat. Hist. Soc.*, **13** : 303-332.

Forel, A. 1901. Les Formicides de l'Empire des Indes et. de Ceylon, Part VIII, *J. Bomb. Nat. Hist. Soc.*, **13** : 462-477.

Forel, A. 1902a. Myrmicinae nouveaux de l'Inde et. de Ceylon, *Rev. Suisse Zool.*, **10** : 165-249.

Forel, A. 1902b. Les Formicides de l'Empire des Indes et. de Ceylon, Part IX, *J. Bomb. Nat. Hist. Soc.*, **14** : 520-546.

Forel, A. 1903a. Les Formicides de l'Empire des Indes et. de Ceylon, Part X, *J. Bomb. Nat. Hist. Soc.*, **14** : 520-546.

Forel, A. 1903b. Les Fourmis des iles Andamans *et* Nicobares. Rappoots de cette faune avec. Ses, viosines. *Rev. Suisse Zool.*, **11** : 399-411.

Forel, A. 1913. Quelques Fourmis des Indes, du Japan et d'Afrique. *Rev. Suisse Zool.*, **21** : 659-673.

Gadagkar, R., Nair, P., Chandrasekhar, K. & Bhat, D. M. 1993. Ants species richness and diversity in some selected localities in Western Ghats, India. *Hexapoda* (Insecta-Indica), **5** : 79-94.

Ghosh, S. N., Chattopadyyay, A. & Bhattacharyya, D. K. 1999. Population abundance, seasonal fluctuation of ants (Hymenoptera : Formicidae) in automobile exhaust fed road side soil of Calcutta. *Rec. Zool. Surv. India*, **97** (Part-2) : 139-148.

Holldobler, B. & Wilson, E. O. 1990. *The Ants.* Cambridge : Harvard University Press, xii+732 pp.

Imai, H. T., Baroni Urbani, C., Kubota, M., Sharma, G. P., Narshimhanna, M. N., Das, B. C., Sharma, A. K., Sharma, A., Deodikar, G. B., Vaidya, V. G. & Rajasekharasetty, M. R. 1984. Karyological survey of Indian ants. *Jpn. J. Genet.*, **59** : 1-32.

Jerdon, T. C. 1851. A catalogue of the species of ants found in Southern India. *Madras J. Lit. Sci.*, **17** : 103-127.

Jerdon, T. C. 1854. A catalogue of the species of ants found in Southern India (part). *Ann. Mag. Nat. Hist.*, **13**(2) : 45-56.

Jerdon, T. C. 1865a. (Untitled. Introduced by : Mr. F. Smith read the following letter from Dr. T. C. Jerdon, dated "Lahore", March 16, 1865). *Trans. Entomol. Soc. Lond.*, (3)**2** (Proceedings) : 93.

Jerdon, T. C. 1865b. (Untitled. Introduced by "reliable information has at last been supplied by Dr. Jerdon regarding workers of one of the Indian species of *Dorylus*"). *J. Asiat. Soc. Bengal,* Part II. *Phys. Sci.*, **34** : 189-190.

Karavaiev, W. 1926. Ameisen aus dem Indo-Australischen Gebiet. *Treubia,* Buitenzorg, **8** : 413-445.

Karavaiev, W. 1927. Ameisen aus dem Indo-Australischen Gebiet. III. *Trav. Mus. Zool. Kieff.*, **3** : 3-52.

Karavaiev, W. 1928. Ameisen aus dem Indo-Australischen Gebiet. IV. Uber Ameisennester, hauptsachlinch von *Polyrhachis* Arten. *Trav. Mus. Zool. Kieff.*, **5** : 3-24.

Kugler, J. 1987. The *Leptanillinae* (Hymenoptera-Formicidae) of Israel and a description of a new species from India. *Isr. J. Entomol.*, **20** : 45-57.

Kurian, C. 1955. Bethyloidea (Hymenoptera) from India. *Agra Univ. J. Res.*, **4** : 67-155.

LaSalle, J. & Gauld, I. D. 1993. Hymenoptera : their diversity, and their impact on the diversity of other organisms 1-26 pp. In. Ladsalle, J. & Gauld, I. D. (Eds.), *Hymenoptera and biodiversity.* Oxford : CAB International, XI+348 pp.

Mathew, R. 1980. Description of a new species of ant (Hymenoptera : Formicidae) from the Khasi Hills, Meghalaya, *Oriental Ins.*, **14**(4) : 425-427.

Mathew, R. 1983. Studies on house-hold insect pests (Hymenoptera : Formicidae) of Shillong, *Bull. Zool. Surv. India*, **5**(1) : 125-127.

Mathew, R. 1984. Some new records of ants (Hymenoptera : Formicidae) from Tripura, *Bull. Zool. Surv. India*, **6**(1-3) : 307-308.

Mathew, R. & Tiwari, R. N. 2000. Insecta : Hymenoptera : Formicidae. Zool. Surv. India, *Fauna of Meghalaya,* State Fauna Series **4**, Part 7.

Mishra, S. K. & Sarangi, U. N. 1984. A scheme for Chandaka elephant reserve. Forest Department (Wildlife Wing), Orissa. 151 pp.

Negi, P. S., Mishra, M. P. & Gupta, S. N. 1930. Ants and the lac insects (*Lacifer lacca*). *J. Bomb. Nat. Hist. Soc.*, **34**(1) : 182-188.

Panda, P. C. 1992. Flora of Puri district. Unpublished Ph.D. thesis. Utkal University.

Ramdas Menon & Panjabo, G. M. 1961. Some observations and new records of ants from Delhi. *Indian J. Entom.* **22** : 133-135 (1961-07).

Reddy, D. N. R., Viswanath, B. N. & Belavadi, V. V. 1981a. Ant fauna of Dharwad (Karnataka state) with special reference to foraging behaviour of *Myrmicaria brunnea* Saunders (Hymenoptera : Formicidae) M.Sc. Thesis, U.A.S. Bangalore, 81 pp.

Reddy, D. N. R., Viswanath, B. N. & Belavadi, V. V. 1981b. A preliminary study of ant fauna of Bisthenhatti, Dharwad. In G. K. Veeresh (ed.). *Progress in soil Biology and Ecology in India,* U.S.A. Technical Series No. **37** : 200-205.

Roonwal, M. L. 1954. On the structure and population of the nest of common Indian tree ant *Crematogaster dohrni rogenhoferi* Mayr (Hymenoptera : Formicidae). *J. Bomb. Nat. Hist. Soc.,* **52** : 354-364.

Roonwal, M. L. 1975. Plant pest status of root eating ant. *Dorylus orientalis*, with notes on Taxonomy, distribution and habits (Insecta : Hymenoptera) *J. Bomb. Nat. Hist. Soc.,* **72** : 305-313.

Rothney, G. A. J. 1890. Notes on Indian ants. *J. Bombay Nat. Hist. Soc.* **5** : 38-64.

Rothney, G. A. J. 1889. Notes on Indian ants. *Trans. Entomol. Soc. Lond.* 1889 : 347-374.

Rothney, G. A. J. 1903. The aculeate Hymenoptera of Barrackpore, Bengal. *Trans. Entomol. Soc. London.* 1903 : 93-116.

Roy, P. S., Moharana, S. C., Prasad, S. N. & Singh, I. J. 1992. *Remote sensing application for characterization of elephant habitats and corridors in Orissa and part of Bihar*. Orissa Remote Sensing Application Centre.

Saunders, W. W. 1842. Description of two Hymenopterous insects from Northern India. *Trans. Entomol Soc. Lond.,* **3** : 57-58.

Sheela, S. & Narendran, T. C. 1997. A new genus and a new species of *Myrmicinae* (Hymenoptera : Formicidae) from India. *J. Ecobiol.*, **9**(2) : 87-91.

Sheela, S. & Narendran, T. C. 1998a. A new species of the genus *Paratopcila* Wheeler (Hymenoptera : Formicidae) from India. *Geobios, new reports*, **17** : 23-26.

Sheela, S. & Narendran, T. C. 1998b. On five new species of *Tetramorium* (Hymenoptera : Formicidae : Myrmicinae) from India. *Entomon.,* **23**(1) : 37-44.

Sheela, S., Narendran, T. C. & Tiwari, R. N. 2000. Redescription of little known Myrmicine and *Recurvidris recurvispinosa* (Forel) (Hymenoptera : Formicidae). *Rec. Zool. Surv. India*, **98** (part-2) : 93-98.

Shivashankar, T. 1985. Studies on the ecology and foraging behaviour of *Leplogenys processionalis* Jerdon, (Hymenoptera : Formicidae). M.Sc. thesis UAS Bangalore, 97 p.

Smith, F. 1852. Description of some Hymenopterous insects captured on India, with notes on their economy, by Ezra T. Downes, Esq., who presented them to the Honourable the East India Company. *Ann. Mag. Nat. Hist.*, (2)**9** : 44-50.

Smith, F. 1871a. A catalogue of the Aculeata Hymenoptera and Ichneumonidae of India and the Esatern Archipelago with introductory remarks by A. R. Wallace (part). *J. Linn. Soc. Lond. Zool.*, **11** : 285-348.

Smith, F. 1871b. A catalogue of the Aculeata Hymenoptera and Ichneumonidae of India and the Esatern Archipelago with introductory remarks by A. R. Wallace (Concl.). *J. Linn. Soc. Lond. Zool.*, **11** : 349-415.

Smith, F. 1873. (Untitled Introduced by "Mr. F. Smith exhibited a further collection of ants sent by Mr. G. A. James Rothney, from Calcutta). *Trans. Entomol. Soc. Lond.*, : 8-9.

Smith, F. 1875. Description of new species of Indian aculeate Hymenoptera, collected by Mr. G. A. James Rothney, member of the Entomological Society. *Trans. Entomol. Soc. Lond.*, : 33-51.

Smith, F. 1878. Scientific results of the second yark and Mission; based upon the collections and notes of the Late Ferdin and Stoliczka, Ph.D. Hymenoptera, Calcutta : superindent of Government printing (Government of India), 22 pp.

Smith, M. R. 1949. A new genus and species of ant from India (Hymenoptera : Formicidae) *J.N.Y. Entomol. Soc.*, **56** : 205-208.

Swain, K. 2000. Socio-economic studies on the flora and fauna of Chandaka-Dampara forest. Unpublished Ph.D. thesis, Utkal University, Orissa.

Sykes, W. H. 1835. Description of new species of Indian ants. *Trans. Entomol. Soc. Lond.*, **1** : 99-107.

Taylor, R. W. 1965. Notes on the Indo-Australian ants of Genus *Simopone* Forel (Hymenoptera : Formicidae). *Psyche*, **72** : 287-290.

Taylor, R. W. 1968. Notes on the Indo-Australian basicerotine ants (Hymenoptera : Formicidae), *Aust. J. Zool.*, **16** : 333-348.

Tewary, R. N. & Guha, D. K. 1977a. A new record of Polyrhachis (Campomyrma) hauxwelli Bingham (Hymenoptera : Formicidae) from India. *Newsl. Zool. Surv. India*, **2**(5) : 210.

Tewary, R. N., Guha, D. K. & Maity, P. K. 1977b. New records of Ponerine ants from Arunachal Pradesh (Hymenoptera : Formicidae) *Newsl. Zool. Surv. India*, **3**(3) : 132-133.

Tewary, R. N. & Maity, P. K. 1977c. Some new records of ants from Arunachal Pradesh (Hymenoptera : Formicidae). *Newsl. Zool. Surv. India.*

Tiwari, R. N. & Jonathan, J. K. 1986a. A new species of *Liomyrmex* Mayr, from Andaman Islands (Hymenoptera : Formicidae). *Rec. Zool. Surv. India*, **83**(1&2) : 87-90.

Tiwari, R. N. & Jonathan, J. K. 1986b. A new species of *Metapone* Forel, from Nicobar Islands (Hymenoptera : Formicidae). *Rec. Zool. Surv. India*, **83**(1&2) : 149-153.

Tiwari, R. N. 1994. Two new species of a little known genus *Myrmcina* Curtis (Insecta : Hymenoptera : Formicidae) from Kerala, India. *Rec. Zool. Surv. India*, **94**(2-4) : 151-158.

Tiwari, R. N. 1996. Hymenoptera : Formicidae. Zool. Surv. India, *State Fauna Series 6, Fauna of of Delhi*, : 441-451.

Tiwari, R. N. 1997. Jaivik Bibidhita Chintiyon Ke Sandarbh mo (Biodiversity in perspective of Ants) (Hindi). *Bharat ki Prani Bibidhita*, Zool. Surv. India : 137-147.

Tiwari, R. N. 1999a. Taxonomic studies on ants of Southern India (Insecta : Hymenoptera : Formicidae) *Memoirs. Zool. Surv. India*, **18**(4) : 1-96.

Tiwari, R. N., Kundu, B. G., Roy Chowdhury, S. & Ghosh, S. N. 1999b. Insecta : Hymenoptera : Formicidae. *Zool. Surv. India, State Fauna Series 3 : Fauna of West Bengal*, **Part 8** : 211-294.

Tiwari, R. N., Kundu, B. G., Roy Chowdhury, S. & Ghosh, S. N. 2001a. Insecta : Hymenoptera : Formicidae. *Zool. Surv. India, State Fauna Series 9 : Fauna of Sikkim*, **Part 3** : 679-717 (In Press).

Tiwari, R. N., Kundu, B. G., Sheela, S. & Ghosh, S. N. 2001b. Insecta : Hymenoptera : Formicidae) *Zool. Surv. India, State Fauna Series 10 : Fauna of Manipur*, **Part 1** : 1-23 (In Press).

Verghese, A and Veeresh, G. K. 1981. Ants of India—a brief review. In C. A. Edwards and G. K. Veeresh (eds.) Sent Biology and Ecology in India *U.S.A. Tech. ser.* No. 22, pp. 172-181.

Veeresh, G. K. and Musthak Ali, T. M. 1990. The present status of our knowledge on Indian ants. In G. K. Veeresh, A. R. V. Kumar and T. Shivashankar (eds.) social Insects. An Indian Perspective Publ. IUSSI—Indian Chapter, UAS Bangalore, 231 pp.

Wilson, E. O. 1964. The true army ants of the Indo-Australian area (Hymenoptera : Formidae : Dorylinae). *Pac. Insects,* **6** : 427-483.