



Morphological description of Ants identified in Tumkur University campus, Tumakuru

A. L. Kokilamani¹, Shobha P. N.¹, Vanitha N.¹ and Latha V.*

¹ Department of Studies and Research in Zoology, Tumkur University, Tumakuru

*Department of Zoology, Maharani Cluster University, Palace road, Bangalore-560001

*Corresponding author: latha.enscience@gmail.com

Abstract: Ants contribute a conspicuous component of terrestrial biodiversity and are the most divergent group among all social insects. They are eusocial insects belong to the family Formicidae, order- Hymenoptera. Morphologically, ants are separated from other hymenopterans by the one or two segmented node (modifies II and III abdominal segments), connecting the alitrunk (thorax plus I abdominal segment fused, this is called as propodeumormesonoma) and the gaster (abdomen proper minus II or III segments) and presence of a metaplural gland. A survey was conducted at Tumkur University campus, Tumakuru to record the morphological differences among the different genera of the family Formicidae. The study was done by adapting all-out-search method for collection, preserving in 70% alcohol, observation and identification through morphological features by literature survey and consulting myrmecologists. During study period the morphological features of about 28 species of 17 genera belong to the subfamilies- Formicinae, Myrmicinae, Ponerinae, Dolichoderinae and Pseudomyrmicinae were recorded. Apart from exhibiting the general ant morphological features, each of the genera has showed their distinct external characters. These distinct characters of different genera form the base for the taxonomical diversification of ant fauna. This survey provides a basic data for the future taxonomical investigation of ant fauna of Tumkur district.

Key words: Ant morphology, Genus characteristics, Formicinae, Myrmicinae, Ponerinae, Dolichoderinae and Pseudomyrmicinae

I INTRODUCTION

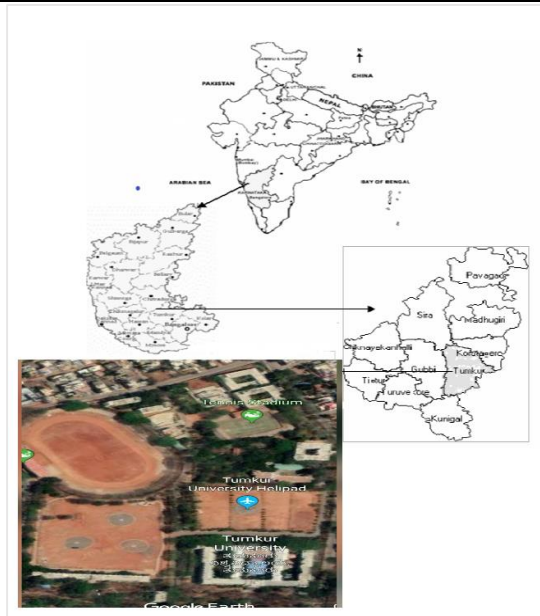
Ants are most dominant components of terrestrial ecosystem because of its universal distribution except in Iceland, Greenland and Antarctica, thus they constitute greater part of biomass and act as ecosystem engineers. They play a very important role in the ecosystem by improving the soil quality and assisting the decomposition process hence, considered as good biological indicators (Watanasit, et al., 2000).

Ants are ubiquitous in distribution and occupy almost all terrestrial ecosystems. There are about 15000 species of ants (Andrade, 2007) only 11,769 species have been described (Agosti, 2000). The family Formicidae contains 21 subfamilies, 283 genera and about 15000 living ant species of which 633 ant species belonging to 82 genera, 13 subfamilies are reported from India. About 226 species of ants belonging to 63 genera and 11 subfamilies are estimated from Karnataka state (Varghese, 2009).

II MATERIALS AND METHODS

2.1 Study area

Tumkur belongs to the group of districts called the maidan (plains) districts of South eastern Karnataka. Tumkur is situated at a distance of 70km (43miles) Northwest of Bangalore at 30° 20' 16" N and 77° 7' 13" E in the plain of Deccan plateau of peninsular India. The climatic condition of the district constitutes monsoon (June to November), Post monsoon (December to February) and premonsoon (March to May) with an average annual temperature of 36° to 38°. The district receives annual rain fall between 600mm to 900mm (Gazette-2015).



**Fig.1: Satellite view of study area, Tumkur University Campus, Tumakuru
(Courtesy: Google map)**

The study was conducted at Tumkur University campus, Tumakuru. It is located in the heart of the Tumkur city and established in 2004. The University campus includes thick vegetation with diverse flora and fauna, distributed in about 90 acres and infrastructure is situated in about 98.800square feet. The campus is free from major anthropogenic activities like construction of buildings, cutting of trees and other vegetation, free from animal grazing and campus include minor anthropogenic activities that too academic oriented and constrained to various buildings of the campus.

2.2 Materials and Methods

Ants are ubiquitous in distribution and occupy almost all terrestrial ecosystems and are one of the important social insects of Hymenoptera. Some of them are ground dwellers - present in rock cervices, in leaf litters, in soil and few are arboreal in habit - present on tree trunk, branches, leaves, some of the ant species exhibit association with other insect groups. As the ants are social insects with various hierarchical levels in the colony, they usually have their colony either on ground or in the cervices of tree trunks or construct a nest on the leaves of the tree.

By keeping all these points in mind, we have searched for ants and for their colony on the ground, leaf litters, soil, on tree trunks and branches of trees during 8.00am to 9.00am and 4.30pm to 6.30pm. As ants are more active and prefer low range of temperature for their foraging activities, we have collected them during morning and evening of every alternate days of our study period.

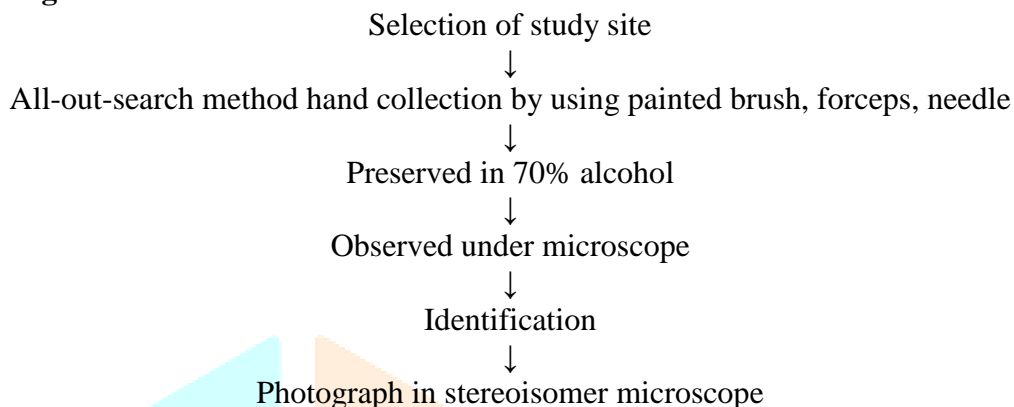
We have also concentrated on different castes of the colony (major or minor worker), nature of colony i.e. Polymorphic or Monomorphic. Such noticed ants were collected by using paint brush, forceps, and needles by adapting all-out-search method. The ants were collected in vials containing 70% alcohol and were brought to the laboratory for further studies and then identified with the help of LAFCO dissection microscope, UNILAB Binocular microscope and Lawrence and Maya stereoisomer microscope and photographed the observed specimen.

The survey was undertaken as follows:

- To record the species diversity of ants the Study was conducted in each Location by dividing the study site into different slots of measuring 25M × 25M area to follow the Quadrature method.
- During field work the photography of individual ant species and their colony and nests were done by using camera Nikon 5000D.
- Ants were collected by hand picking using sharp forceps, needle and camel brush by adapting all-out-search method. And also by offering them baits like sugar, jaggery and rice grains.
- The ants were collected in vials containing 70% alcohol and were brought in to the laboratory for further identification.
- The information about date and time of collection, habitat, and locality was also recorded at the time of collection in the field note book.

- The collected ants were separated as different castes and were identified upto genus level with the help of available literature (Holldobler and Wilson,1990; Sheela, 2008) and hand book of the ants for peninsular India (Ajay Narendra and Sunil Kumar, 2006) and also by referring ant wiki, ant web, ant store website.
- The species level identification was done by seeking the help of experts from Department of Entomology, University of Agricultural Science, GKVK, Bangalore.
- The collected ants were observed under the LAFCO Dissection microscope, UNILAB Binocular microscope for key morphological features, and the same were photographed under Lawrence and Maya stereoisomer microscope, field survey photography was done by using camera Redmi Y2 and Redmi Note 5 Pro.

2.3 Sampling design



2.4 General Ant Morphology Ants range in size from 0.75 to 52mm. They vary in colour, most are red or black but few species are green and some tropical species have a Metallic lusture(Holldobler and Wilson, 1990). The ant body is generally divided into head, trunk, petiole and gaster. Some of the major morphological features are shown in (Fig.2).

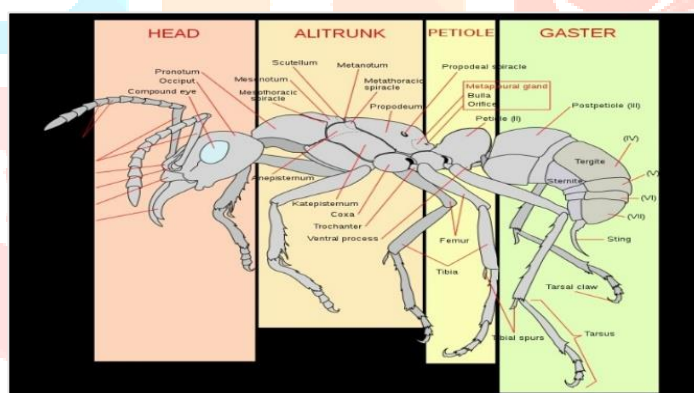


Fig.2: Morphological features of Worker Ant *Paphycondylaverenae*
(Courtesy: Source:Thresiamma Varghese, Homepage)

2.4.1 HEAD

The head varies in shape and size. It consists of eyes, clypeus, frons, vertex, genae, antennal and mouthparts. The size and position of the eyes are highly variable.

Sometimes the absences of eyes also form an important identifying character for some species. The mouth parts contain mandible, maxillae, labium and an unpaired labrum. The region bounded anteriorly by the posterior end of clypeus and laterally by a pair of ridges.

The shape, size and the appearance of the frontal area are highly variable and are very important. The region between the vertex and foramen is the occiput. The portion anterior to the eyes and late to the frontal prinae constitutes genae. This is divided into two equal halves by a longitudinal suture. In the frontal view mandibles are articulated usually on the lateral corner of the head and are seen below the clypeus. In some species the mandibles are articulated in the middle (Fig.2a and 2b).

Fig.2a: Head of ant showing clypeus

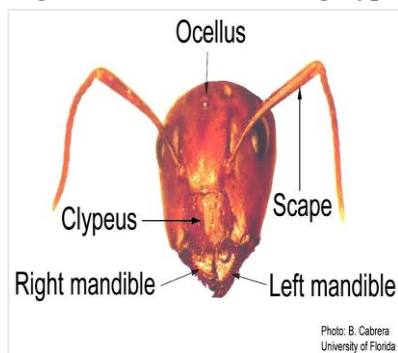
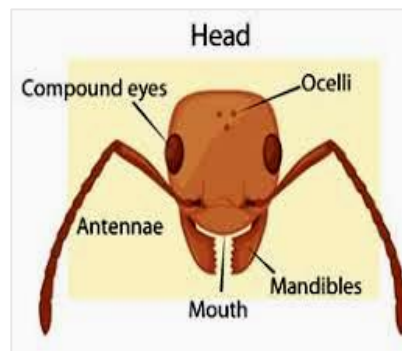


Fig.2b: Head of ant showing Mandibles



(Courtesy: Source: Ant.biologist.asu.edu.)

The structures like number of segments on the maxillary and labial palps are of very important in diagnosis of the species. The number of segment, its relative size and nature of the antennae also vary greatly with species and the number of antennal segment varies from 4 to 12. The elbow shaped structure of antenna is the characteristic of ant community.

2.4.2 THORAX

Ant thorax is basically formed of prothorax, mesothorax and metathorax (Fig.2). The lateral sclerites of thorax are propleuron, mesopleuron and metapleuron respectively, and metapleuron gland is present. But in all ants in addition to these 3 segments tergites of the first abdominal segments is fused to the thorax and form the propodeum. The thorax varies greatly in shape, size & appearance with sex, castes & with different species. It bears 3 pairs of jointed appendages, the legs and the 2 pairs of wings.

Legs:

The six legs of an ant extend from its thorax. Further more, an ant's legs are segmented into several different parts such as Coxa, Trochanter, Femur, Tibia (with tibial spurs), Tarsus (with five tarsomeres) and Pre-tarsus (with a tarsal claw) (Fig. 3).

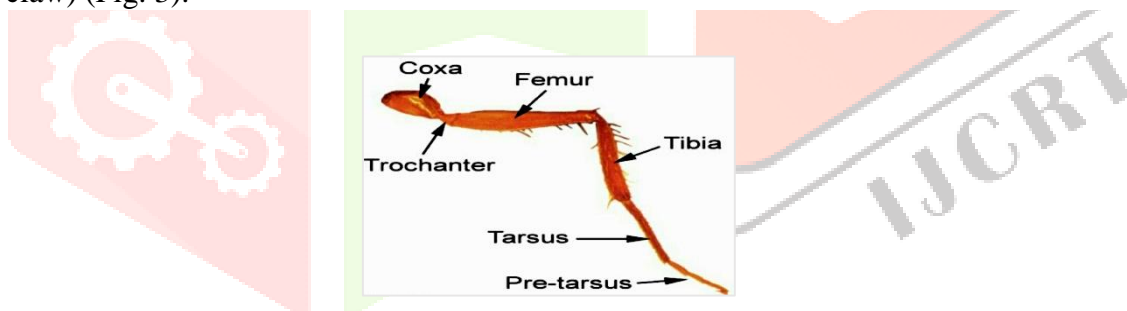


Fig. 3: structure of ant leg

Wings:

The majority of ants are wingless. Winged female ants and males typically swarm after a day of heavy rain in a particular season. These winged ants often are called alates, swarmer or reproductives. Queens begin as winged ants and usually shed their wings after mating and reproductive males die. Winged ants have elbowed antennae, thin waists constricted at the thorax and hind wings smaller than their front wings. This helps to distinguish them from another insect that produces winged individuals, i.e. termites.

2.4.3 ABDOMEN

The abdomen in ants is highly specialized and consists of 7 segments. The first segment is fixed with the thorax and forms the propodeum, The second segment is always reduced and it is separated from remaining abdominal segments and forms a narrow waist and petiole. Sometime the 3rd segment is also reduced and separated to form the post petiole, the rest of the segments constitute the proper gaster. Each abdominal segment consist of a pair of sclerites a dorsal tergite and a ventral sternite. In workers the last abdominal tergite is the pygidium and the last visible sternite is the hypopygium. In all members of the subfamily formicinae, the effects of the

hypopygium give rise to the acidopore. In most formicinae the acidopore is always exposed, but in some it may be cancelled by the posterior margin of the pygidium. The terminal segment of the gaster in females of some species bears an organ of defence i.e. sting (Fig. 4). (<http://ces.iisc.ac.in/thresi/antsOfIISc/Welcome.html>).

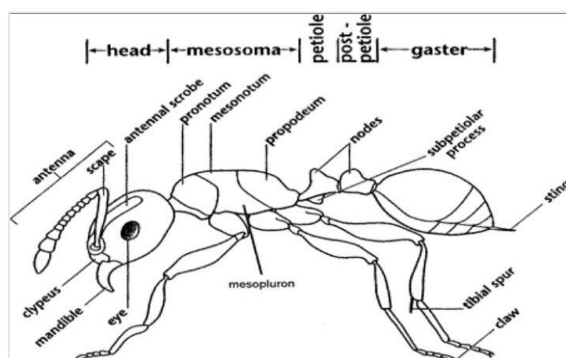


Fig.4: Showing thorax and abdomen

III Results and Discussions:

3.1 Description of observed ant species

3.1.1 Subfamily: Myrmicinae

Many of them exhibit polymorphism where each caste has specialized duties within the colony. Some species are overly aggressive, some are hunters, others scavengers. The mesosoma is attached to the gaster by two segments, the petiole and post petiole. The mandibles are generally triangular, pronotum and mesonotum are fused into a single plate. Eyes are small and round, body compact. The following genera and species of the family were observed (Fig 5).

3.1.1.1 Genus: *Crematogaster*

In the *Crematogaster* genus the gaster is heart shape, eyes are medium size, promesonotum is more or less raised. Promesonotal suture absent or weakly present dorsally, Propodeal spine usually present, varying in size and shape. Propodeal spiracle located well posteriorly on posterolateral margin of propodeum, just below the base of propodeal spine. Petiole is depressed dorsoventrally, without node. The postpetiole in dorsal view is broadly attached to the first gasteral segment and the first gastral segment behind the postpetiole is extremely dorsoventrally compressed in lateral view. Examples: Species: *C. biroi*, *C. cerasi*, *C. pilosa*, *C. rothneyi*, *C. subnuda*

3.1.1.2. Genus: *Meranoplus*

Species of this genus are predominately ground nesting and when disturbed individuals accumulate dirt in their pilosity and play dead. Most species are Omnivorous, these are active both day and night. Foraging is performed primarily on ground or in leaf litter. Whereas only very few species may additionally climb up trees or shrubs. Examples: *M. bicolor*

3.1.1.3. Genus: *Monomorium*

In *Monomorium* genus the antennae is 12 or 11 segmented with distinct 3 segmented club, petiole is distinctly pedunculate, metapleuron gland is well developed, promesonotal suture reduced or absent. Promesonotal suture reduced or absent, metanotal sulcus present as pronounced constriction. *Monomorium* species were found in open area, vegetative area. The mandibular shape is triangular. Examples: *M. criniceps*, *M. minimum*, *M. pharaonis*.

3.1.1.4. Genus: *Pheidole*

The genus is wide spread and ecologically dominant. It probably includes more than a thousand species. Most species of *Pheidole* are dimorphic, which means that colonies contain two castes of workers that are major worker and minor worker or soldiers. The latter generally have enormous head and mandibles in comparison to their usually fairly modest body size. In addition, as in other ant species, a colony may contain one or several queens and also in mature colonies, alates, virgin winged females and males. Examples: *P. rhea*, *P. pilifera*

3.1.1.5. Genus: *Solenopsis*

These are commonly referred to as fire ants because of the intense, burning sensation caused by their sting. 2 segmented petiole, 2 segmented antennal club, propodeum lacking spines, Petiolar node well developed, head and body shining, apical marginal setae is present. 2 segmented petiole, 2 segmented antennal club, propodium lacking spines or angles, petiolarnode well developed, head and body shining. The median apical marginal setae are present. Examples: *S. geminata*

3.1.1.6. Genus: *Trichomyrmex*

These are usually polymorphic, antennae 12-segmented, mastigatory margin of mandibles armed with 3-4 teeth, when 4th basal most tooth is reduced to an offset denticle or blunt angle. Propodeum unarmed, with transversely sculptured dorsum, Propodeal spiracle usually circular to sub circular. Examples: *T. destructor*

Subfamily: Myrmicinae



Fig. 5: Species of the subfamily: Myrmicinae

3.1.2 Subfamily: Formicinae

Ants belonging to this sub family exhibit remarkable adaptations and occupy a range of micro habitats from tree canopies, to crevices in houses and buildings. Many of these ants exhibit symbiotic relations with various hompoterans such as aphids and coccids. Workers have a flexible promesonotal suture, closed metacoxal cavities; mesosoma is attached to the gaster by a single distinct segment called the petiole. The gaster is smooth, without constrictions between the segments. The sting is absent. The following genera and species of the family were recorded (Fig 6).

3.1.2.1. Genus: *Anoplolepis*

Anoplolepis is a relatively small genus with only nine valid species. These formicines are epigaecic and active ants that forage on the ground or the vegetation. Their diet is comparatively variable since they feed on a variety of small arthropods but also on honeydew produced by aphids or coccids. Antennal segment count 11, Antennal club gradual. 1 simple eyes present. Caste most monomorphic, several species polymorphic, sting absent. Examples: *A. gracilipes*

3.1.2.2. Genus: *Camponotus*

They build nest in side wood consisting of galleries chiewed out with a mandibles, preferably in dead, damp wood. They donot consume the wood, however, unlike termites. The head of the major worker much less enlarged and less emarginated posteriorly. Mandibles strongly arched, mesosomal dorsum arched. Pronotal dorsum is rounded or sometimes depressed.

Examples: *C. compressus*, *C. irritans*, *C. japonicas*, *C. pennsylvanicus*, *C. sericeus*.

3.1.2.3. Genus: *Oecophylla*

These are mostly orange in colour, sometimes species ha bright green gasters. These ants have a long strong legs, long flexible antennae and large mandibles allow for a painful slicing bite, these very aggressive and responsive to disturbance. These are best known for their remarkable nest construction. The ants were noticed to secrete a silk that is used to stitch leaves together to create a nest. It is represented by the following species: *O. smaragdina*.

3.1.2.4. Genus: *Paratrechina*

In these the mandibles are with 5 teeth, maxillary palps 6 segmented, erect setae on dorsum of head randomly placed, scapes lacking erect hairs, abundant erect setae on legs and dorsum of mesosoma. Eyes well developed and convex, overall mesosoma shape long and slender. The following species represents this genus. Example: *P. longicornis*

3.1.2.5. Genus: *Plagiolepis*

The eyes and apex of gaster black, head is distinctly longer than broad, mesosoma is elongated and smooth, the propodeal spiracle is minute and circular. Eyes are relatively large, head dorsum smooth and shining. Scapes distinctly longer than broad. Examples: *P. jerdonii*

3.1.2.6. Genus: *Polyrhachis*

Antennae 12 segmented, the scapes inserted some distance behind the posterior clypeal margin. Mandibles usually with five, rarely with four teeth. Eyes are well developed. Promesonotal suture is usually present, the development of the metanotal groove variable. Petiole usually with four spines, gaster large, globose. These are arboreal ants. It is represented by the species *P. rastellata*.

Subfamily: Formicinae Genus: *Camponatus*

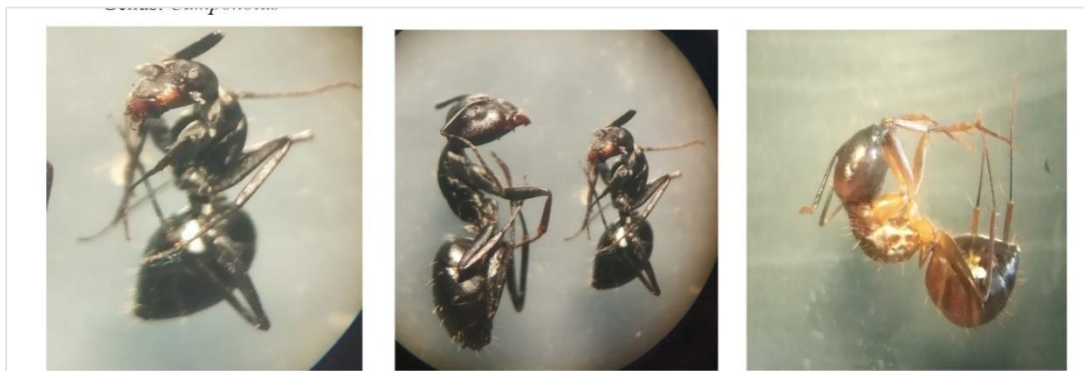


Fig. 6a. *Camponatus compressus* 6b. Polymorphic of *C. compressus* 6c. *C. irritans*

3.1.3 Subfamily: Dolichoderinae

The most commonly occurring dolichoderines are *Tapinoma* and *Technomyrmex*, both found predominantly in ecosystem. Most of the species are scavengers, the sting is absent and the tip of the gaster is slit like and without circular opening, petiolarpeduncle short or absent, the tip of the gaster like a slit and has no hairs (Fig 7).

3.1.3.1. Genus: *Tapinoma*

Most of the *Tapinoma* species are arboreal, they are scavengers, petiole is reduced or absent. First gastral segment projecting anteriorly and concealing petiole in dorsal view. Dorsal face of the propodeum shorter, hairs are generally absent on propodeum. Antennal club and sting are absent. Eyes are approximately round in shape. It is represented by the species *T. melanocephalum*.

3.1.3.2 Genus: *Technomyrmex*

They generally feed honeydew produced from homopterans, antennae is 12 segmented, metanotal groove present. Mesotibia and metatibia each with one spur, that on the metatibiapectinate. Petiolar scale reduced or absent, first gastral segment projecting anteriorly and concealing petiole in dorsal view. Generally few hairs are present on pronotum. It is represented by the species *T. albipes*.

Subfamily: Dolichoderinae

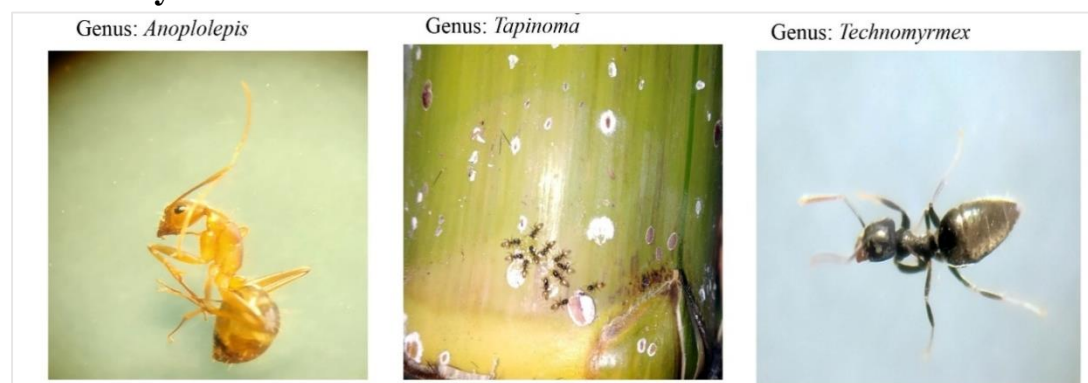


Fig7a. *Anoplolepis gracilipes* 7b. *Tapinoma melanocephalum* 7c. *Technomyrmex albipes*

3.1.4 Subfamily: Pseudomyrmicinae

A very distinct group of ants with elongated eyes and long slender bodies, pronotum is connected to the next segment by a joint. They are arboreal ants preferring to nest in crevices of trees. These ants are solitary forager, they are extremely aggressive and are equipped with a sharp sting. These have large eye, the sting is present, pronotum and mesonotum are unfused, antennae with 12 segments. Mandibles are relatively short.

3.1.4.1. Genus: *Tetraoponera*

These have broad head, mastigatory margin of mandibles with five teeth, eyes are relatively small, pronotum with lateral margins well developed, mesosoma and petiole usually lighter orange brown, head and gaster dark brown to brownish black, mandibles, antennae, protibia and tasi medium brown to yellowish brown in colour. Example species *T. rufonigra* (Fig 8a).

3.1.5. Sub family: Poneriae

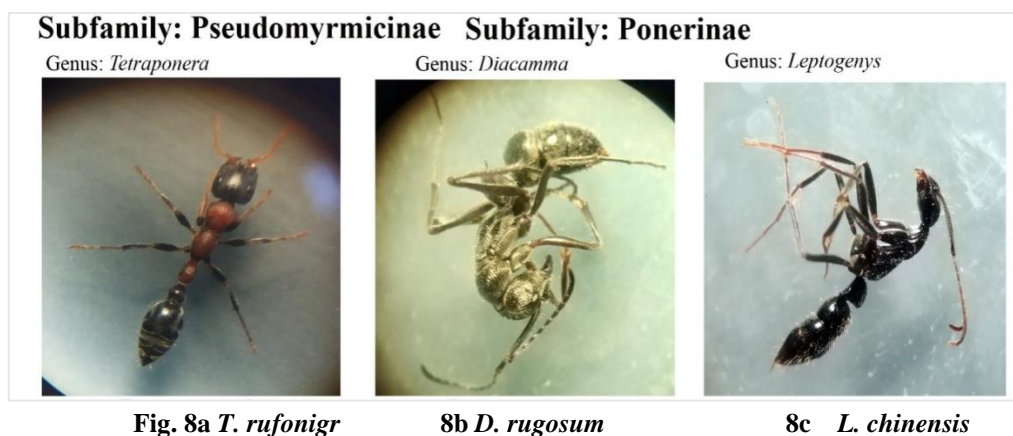
This subfamily comprises of some of the most primitive Indian ants, which have specialised feeding habits. Most of these ants are solitary foragers and predators. They survive by hunting and feeding on several varieties of arthropods ranging from small insects. These are equipped with extremely modified mandibles to suit their hunting needs, the worker castes are always monomorphic. Last gastral segments are smooth.

3.1.5.1. Genus: *Diacamma*

These are easily identified by the presence of deep striate sculpturing, deep pits on the sides of the mesosoma and bispinose petiole. The workers are monomorphic in nature. These species forage individually, nests are usually construct in soil. Example :*D. rugosum* (Fig 8b).

3.1.5.2. Genus: *Leptogenys*

Workers are usually found foraging, they nest terrestrially under the soil, rocks, root mat ground layers and rotten tree stumps. Mandibles are sub triangular to curvilinear. Eyes are small to large, placed at or anterior to head midline. Metanotal groove shallow to deeply impressed. Propodeum broad to moderately narrowed dorsally. Propodeal spiracles usually small and round though occasionally a short slit. Tarsal claws usually pectinate, head and body usually shining, usually no pubescence. Mandibles are either triangular or subtriangular, frequently elongate with subparallel internal and external margins. It includes following species *L. Chinensis* (Fig 8c).



4. CONCLUSION

The morphological characteristics give valuable information which helps taxonomists to a great extent because they are easy and can conventionally be used in the classification and phylogeny of organisms. Ants are a spectacular evolutionary success (Hölldobler and Wilson, 1990). Different species have adapted their bodies and behaviour to exploit almost every conceivable ecological niche on earth. Knowing the anatomical details seemingly a simple technical means, but it has specialised role on ant behaviour, as well as the meticulous reconstruction of the phylogeny of ants (Diethard Tautz, 2014). Although the biological research is dominated by molecular approaches, knockouts and the whole genome analysis, the classical study of pure comparative anatomy and phylogenetic remain as powerful as ever.

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