# State of Isopteran Biodiversity in the Indian Subcontinent

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***Abstract-*** Nature is the treasure house of assorted divine mysteries. The evolution of life is one such mystery that has been boggling the minds of the erudite for years. Evolution begets diversity and insects are the most exuberant manifestation of diversity on the face of earth. 7.10% of the world entomo-fauna finds refuge in the Indian subcontinent. Their mega diversity has incited colossal interest in the evolutionary history of this group. Isopterans are a highly successful group of insects forming a major proportion of the soil macro fauna of the world. In India they comprise some of the most significant agricultural and household pests constituting 11.2% of their worldwide diversity. *Odontotermes obesus*, *O.brunneus*, *O.redemanii*, *O. feae* and *Microtermes obesi* are the most important pests in the Indian subcontinent.

***Keywords -*** *Diversity, Isoptera, India, Pests*

## I. INTRODUCTION

As per [1], insects are the 'little things that run the world'. ‘‘Success’’ of a species or group of species is typically either ecological or evolutionary and by most measures the evolutionary success of insects is unrivalled. The reason for the incredible evolutionary success of insects is particularly, their long- term persistence due to the early origins in the Devonian (approx 400 MY) and subsequent radiation into millions of species. By and large the class Insecta owes its prodigious comprehensive ecological dominance in the terrestrial ecosystems to the social insects, both in terms of biomass and impact on biological communities. Thus, sociality is perhaps the most striking and stupendous innovation of insects. The phenomenon of sociality ranges all the way from mere ephemeral union of the sexes to a feeble gregariousness of individuals to highly integrated enduring societies. The research on these tiny creatures is just as endless, extensive and exquisite as the social insects themselves. Social insects have long been prized as exceptionally valuable model organisms in physiology, behavior and evolutionary biology. The number of described insect species has grown by leaps and bounds in the past few years. [2] recorded the presence of 1,004,898 described species as opposed to 925,000 species recorded by [3]. But, scientists believe that a remarkable proportion still remains veiled, largely due to the lack of pronounced morphological differences between the species.

India, being distinguished as one of the 12 mega bio-diversity countries of the world [as per World Conservation Monitoring Centre of the UN Environment Programme (UNEP-WCMC)], is home for an unusually large number of endemic insect species. 61,171 species of insects pertaining to 27 orders are known in India [4] accounting for approximtely 6.2% of the worldwide species distribution.

## II. ISOPTERAN DIVERSITY

Isoptera is a minor insect order with a worldwide distribution. Termites are a highly successful group of insects forming a major proportion of the soil macro fauna of the world. Termites are widely distributed throughout the tropical and sub-tropical regions, close to the equator, while fewer species live at higher altitudes. Some termite species extend their range of occurrence to the relatively cool zones of temperate regions.

Termites embody an integral component of the ecosystem with an estimated 3105 species (including the extinct ones), 2,958 being the number of extant species described so far [5], distributed over 330 genera. However scientists believe that a large number of termite species still remain undescribed. The Indian termites however share a very small proportion of the global fauna with 52 genera/16%, comprising 332 species/11.2% of which 172 species are endemic to the Indian subcontinent.

As per the most widely accepted present day classification [5], Isoptera comprises twelve families divided into two groups:

- Lower termites with hindgut protozoa: Cratomastotermitidae, Mastotermitidae, Kalotermitidae, Hodotermitidae, Termopsidae, Archotermopsidae, Stolotermitidae, Archeorhinotermitidae, Stylotermitidae, Rhinotermitidae and Serritermitidae
- Higher termites without gut protozoa: Termitidae which is divided into 8 subfamilies with 238 genera comprising 2072 living species.

## III. ORIGIN OF TERMITES

Fossil evidence suggests that termites appeared probably in the early Cretaceous i.e. 110-135 Ma [5] and the divergence from the roaches occurred during the late Jurrasic. The first fossil of the family termitidae is however reported from a much more recent period, dated to the early Eocene i.e. 50 Ma [6] after which they exploded in diversity and profusion in the Late Paleocene and Eocene. Despite their wide economical and ecological significance as pests and decomposers and inspite of being one of the most speciose groups of eusocial insects, the evolutionary relationships of Isopterans continue to remain under the veil. In the past decade, several comprehensive studies have been carried out on the phylogenetic positioning of termites for a better understanding of their divergences. For this purpose, several authors have exploited recent molecular techniques in addition to the traditional taxonomic characters [7].

## IV. TYPES OF TERMITES

The nest built by the termite society refers to the complexity of their social organization, diet, biology and environmental factors on the site but there is the large scale of variations. Some of the termite species create only simple galleries in wood or ground while others build the nest of large dimensions and complexity.

On the basis of their living habitat, termites can be grossly placed into two groups:

- The wood dwellers (Dampwood termites; Drywood termites)
- The ground dwellers (Subterranean termites)

Termites feeding and nesting on rotting logs, old tree stumps are dampwood termites and those inhabiting sound dry structural lumber or wood furniture, not requiring an external source of moisture are the drywood termites. In both these types, the connection of the nest with the ground is undesirable. On the contrary, the subterranean termites (ground dwellers) live underground and need contact with soil to meet the moisture requirements of the colony. Subterranean termites are the fiercest of all the 3 kinds, attacking the wooden edifice in their quest for cellulose. They account for approximately 80% of the total amount spent worldwide on termite control annually [8].

Subterranean termites belong to the families, Mastotermitidae, Hodotermitidae, Stylotermitidae, Rhinotermitidae and Termitidae. They construct underground nests, some of them inhabiting diffuse nests in the soil, some build mounds, and a few inhabit arboreal nests on trees with connections to the soil. Subterranean termite mounds are certainly admirable natural structures reaching up to 6 meters in height and 4 meters in base diameter traversed by galleries, sheeting (tunnels) and fungal combs (Figure 4) The structural designing of the termite nests comprising of chambers connected by galleries is in such a manner that it ensures proper temperature, humidity and ventilation. The underground sheetings built by termites can be meters long and often reach the level of ground water or the bedrock and are meant for protection from predators, to prevent desiccation and to maintain a constant micro-climate while foraging. Within their nests, termites live in a harmonious symbiosis with fungul combs comprised of the genus *Termitomyces* Heim, 1958 (basidiomycete) which serve as the medium for digesting cellulosic food material for the colony. Above the ground they gain access to victuals through shelter tubes comprising of a network of branches systematically reaching up to the feeding grounds. The general scheme of nest of subterranean termites is shown in Figure 1 [9].

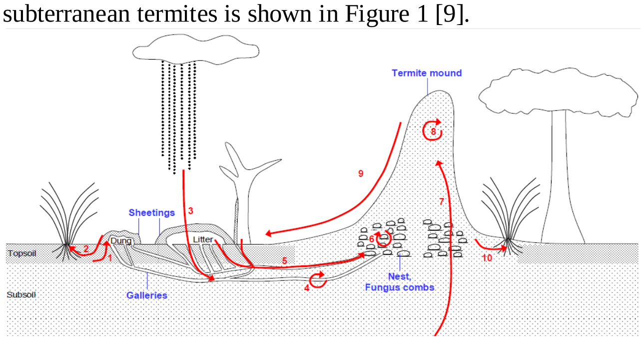


Figure 1: Generalized scheme of nest constructions (blue labels) built by Subterranean species and processes (red arrows) mediated by them 1: soil bioturbation via the construction of sheetings; 2: uptake of nutrients from the sheetings by plants; 3: increase of infiltration rates; 4: aeration of the soil; 5: relocation of organic matter; 6: decomposition; 7: soil turbation via the construction of mounds with subsoil; 8: mineralisation and enrichment of nutrients; 9: erosion and redistribution of mound material; 10: uptake of nutrients from the mound material by plants.

## V. SUBTERRANEAN TERMITES

Subterranean termites include the most destructive termite pests but at the same time they strongly influence soil functioning, by regulating soil properties such as aeration, porosity, water infiltration and storage. Within the Subterranean termites the family Termitidae and Rhinotermitidae comprise some of the most economically important pests. Termitidae is the biggest Isopteran family covering 238 extant genera with approximately 2072 living species, a diversity that has seriously hampered efforts at unraveling phylogeny. As per estimates >20% of members of this family are serious pests. The family Termitidae is distributed in Oriental Region; Ethiopian Region; Australian Region; Neotropical Region; Nearctic Region; Papuan Region and Palearctic Region and comprises of eight subfamilies: Macrotermitinae, Sphaerotermitinae, Foraminitermitinae, Termitinae, Apictotermitinae, Syntermitinae, Cubitermitinae and Nasutitermitinae [5].

The termite diet has largely diversified in the family Termitidae where it includes several kinds of organic matter: sound or decayed wood, litter, grasses, lichens, soil organic matter, and fungi that members of the subfamily Macrotermitinae cultivate in their nests.

The members of family macrotermitinae are the important keystone species in the Asian and African tropics and account for not less than 90% of the worldwide damage caused to forestry, agriculture, and economic structures. It is the most economically important termite subfamily that attacks crops in India [10]. Within the family Macrotermitinae, the genus *Odontotermes* and *Microtermes* comprise 54% and 17% of the described species respectively. Numerous studies from the Indian subcontinent have recorded the predominance of these species. For instance in a recent survey conducted in the northwestern region of India, [11] recorded 52.16% pest species belonging to the genus *Odontotermes*. Both of these genera include some of the most notorious pests of agronomic crops, forests and wood.

In a study conducted by [12] in the Bhadrachalam Forest Region of Andhra Pradesh, out of the 13 species studied *O.obesus* (24%), *O.brunneus* (16%), *O.redemanii* (13%) were found to be the top plant pests. *Odontotermes feae* (6%) and *Microtermes obesi* (3%) were also recorded as significant plant pests.

Isopterans are known for their super architectural ability, cryptobiotic nature of life and enormous economic importance. But, the word 'termite' instantly brings up an imagery of devastation and destruction in one's mind, but surprisingly all termite species are not pests. However, only a small proportion (12.4% i.e 371/2958 species) is accountable for the extensive ravages attributed to these insects of which only 3.5% are considered serious pests. Nonetheless, the havoc caused by these relatively few species is massive and across-the-board.

Termites are the most important decomposers in lowland tropical ecosystems, where they make up to 95% of the soil insect biomass. Termite species diversity is greatest in closed canopy tropical rain forests where Termitidae contributes over 90% of the species [13]. The Termitidae, in addition to being the largest family also exhibits the widest range of ecological and behavioral diversity.

Due to the vast economic importance of the organisms, it has become vital to study them thoroughly in order to trace their origin and to establish the data, not only at morphological level, but also at molecular level, so that they can be precisely identified and can be treated in the favorable way. Though a good deal of work has been carried out on the taxonomy of Indian termites based on their morphological aspects, identifying workers and separating soldiers of different species is very difficult and inspite of using precise measurements, overlap may occur. Molecular markers are particularly useful where morphological and ecological observations are ambiguous [14].

## VI. CONCLUSION

A well constructed phylogeny of Isopteran species will help us to address many questions related to management of their biodiversity under future climate. Proper identification of species is imperative for generating accurate termite phylogenies for effective management of these insects in urban settings and for establishing an environmentally sound management strategy.

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