

## **TERMITES: GENERAL FEATURES AND ECOSYSTEM SERVICES**

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### **Summary**

Termites are a group of eusocial insects classified at the taxonomic rank of order Isoptera. They are closely related to cockroaches and they are thought to have evolved from a primitive cockroach-like ancestor approximately 200 million years ago. Termites live in colony and are composed of individuals representing different specialized castes that differ in behavior and performed specific colony functions. Termites mostly feed upon dead vegetal material, generally on wood, leaf litter that which is in contact with soil. They are mainly tropical in distribution, and in these areas, they play a major beneficial role through promotion of essential ecological processes in agroecosystems in conflict with their well-established role of pests. Indeed, termites can be major agricultural pests, particularly in Africa and Asia, where crop losses can be severe.

Counterbalancing this is the greatly improved soil properties and availability of resources for other organisms including plants and microorganisms through their ecological engineering effects. Such termites belonging to the subfamily of Macrotermitinae are found in tropical and subtropical areas where they are also beneficial by aiding in reduction of recalcitrant cellulosic material into compounds that are further used by other living organisms. Termites are therefore of great interest to biologists and those

concerned with pest management. On the one hand their complex social lifestyles and nest buildings make them fascinating for the study of insect behavior, while on the other they cause serious damage to buildings, crops or plantation forests in the tropics.

## 1. Introduction

Termites are social insects related to cockroaches and are scientifically classified under the order Isoptera. They have a highly evolved social organization and hierarchical structure. They are living in colonies of various sizes containing a number of different castes which include workers, soldiers, nymphs and larvae. The colony may have from a few hundred individuals to millions and each caste is vital to the viability of the colony and also has a different function. Termites undergo gradual metamorphosis: egg -nymph -adult. The young nymphs are fed and cared for by the workers. During molting the young nymphs gradually emerge into different castes. Although almost all termite species feed on dead plant material at different stages of decomposition, their food sources are diverse and also included soil organic matter, litter, dry grass or bark.

This great variation of feeding substrate is linked to the diversity of their gut-associated microbes. All existing termite species have mutualistic relationships with flagellate cellulolytic protozoa living in their guts except for the Termitidae family in which the flagellates have been lost and replaced by fungi in the Macrotermitinae sub-family or prokaryotes in other Termitidae. About 330 of the 2,600 known termite species are obligately dependent on the cultivation of a specialized fungus, from the genus *Termitomyces*, for food. *Termitomyces* is grown on termite feces in subterranean combs that the termites construct within the heart of nest mounds. Termites are mainly tropical in distribution, with highest species richness found in tropical forests where they are major decomposers. Of the more than 2600 described species of termites only a few hundreds are destructive feeders and consume homes and agricultural crops. Among them around 50 species are considered to be serious pests. Counterbalancing this is their significant role in the delivery of ecosystem services through improvement of soil physical, chemical and biological processes.

This impact of termites is due to their ability to build organo-mineral structures with specific physicochemical properties (the so-called biogenic structures) such as nests, mounds or tunnels. During the 2000s, termites have been extensively studied and data covering most fundamental aspects of termite science are available. Also, latest advances in the field are well-synthesized in many recent books such as “biology of termites: a modern synthesis”. Therefore, in responding to the invitation to address this topic, this author’s contribution does not address in detail scientific aspects that were already sufficiently covered by other scientists, but rather it gives more personal view on the topic with, as much as possible, an emphasis on the African continent. The author then deliberately presents some general termite characteristics including their biology, sociobiology and pest status, and also highlights their still poorly-known ecological functions as well as their important beneficial ecosystem services.

## 2. Classification and Diversity of Termites

The scientific classification of termites is as follow: Kingdom: Animalia Phylum:

Arthropoda Class: Insecta Subclass: Pterygota Infraclass: Neoptera Superorder: Dictyoptera Order: Isoptera

Termites are classified into 280 genera and over 2600 species within seven families and 14 subfamilies. The isopteran are phylogenetically separated into lower termites (Mastotermitidae, Kalotermitidae, Hodotermitidae, Termopsidae, Rhinotermitidae and Serritermitidae) and the higher termites (Termitidae). This latter family (Termitidae) is the largest and represents over 85% of all termite genera and 70% of all termite species. The Termitidae of which members lack symbiotic cellulolytic protists in their gut is the most evolved group with a specialized microbial flora, an extensive social system and diverse feeding habits.

Of the five subfamilies within the Termitidae, the subfamily Macrotermitinae consists of 14 genera with about 330 species. This sub-family has developed a mutualistic relationship with a basidiomycete fungus belonging to *Termitomyces* genus. The Macrotermitinae termites are distributed across the Palaeotropics with the highest diversity of genera in Africa. Many people confuse termites with ants; hence termites are often called "white ants". A closer look at both groups of insects, apart from a difference in color, reveals two easily observed distinguishing features: termites have straight antennae and a broad waist, while ants have elbowed antennae and a narrow waist.

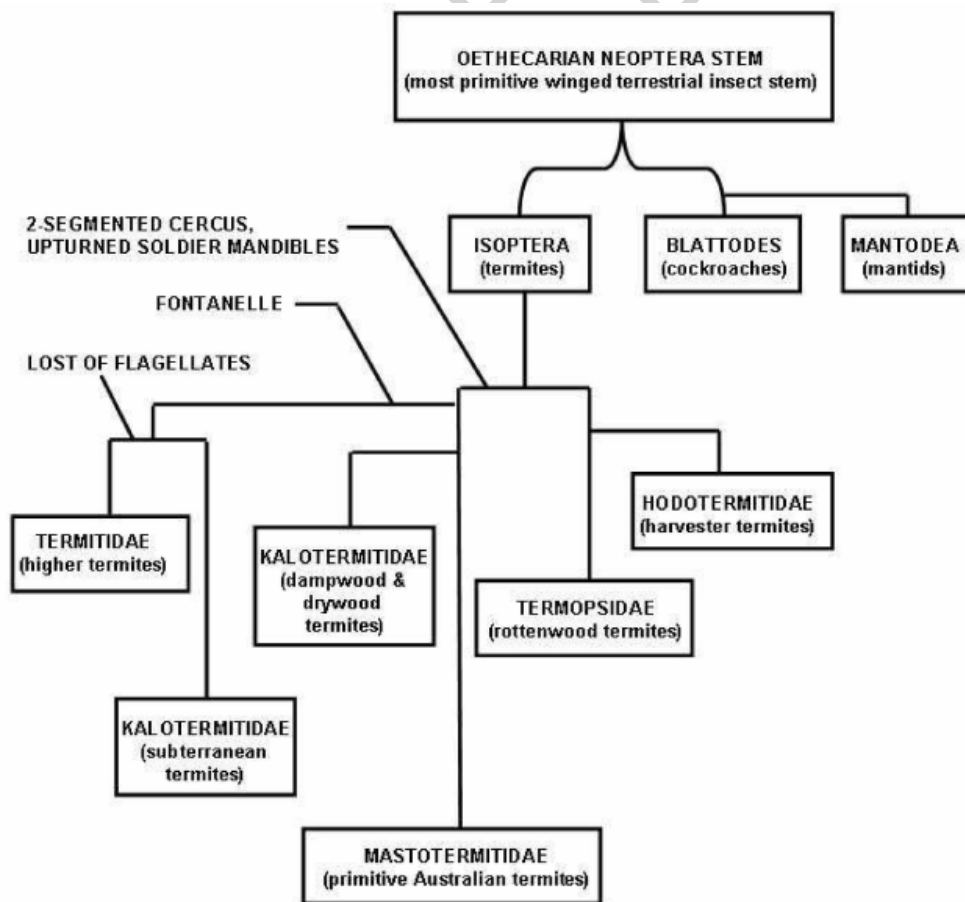


Figure 1. Isopteran phylogenetic tree

The phylogeny position of termites has been long debated. Termites are closely related to cockroaches and mantids, and they are therefore classified in the same superorder Dictyoptera. Termites are thought to have evolved from a primitive cockroach-like ancestor approximately 200 million years ago. The origins of termites probably go back as far as the Upper Jurassic. All known fossils are from the Cretaceous Period and appear to be relatively primitive. However, the distribution of modern termite families suggests evolution and dispersion before the break up and drifting of continents in the Cretaceous Period about 130 million years ago.

The current thinking is that there was an explosive radiation and dispersion of termites during the Tertiary Period and not early evolution or drifting continents that produced their current distribution and dominance as primary herbivores on plant material. The closest living relative of termite is the wood-feeding cockroaches from the genus *Cryptocercus* to which the primitive *Mastotermes darwiniensis* shows some similarities. However, some scientists have recently addressed the taxonomic issue of having an order (Isoptera; termites) nested within another order (Blattaria/Blattodea; cockroaches) and proposed that termites be reclassified and placed in a single family Termitidae.

Indeed, they found that bacteria from the gut of termites and cockroaches from the genus *Cryptocercus*, share the strongest phylogenetical similarities when compared with other cockroaches. Both termites and *Cryptocercus* also share similar morphological and social features (most cockroaches do not exhibit any social behavior, but *Cryptocercus* takes care of its young and shows other social characteristics). However, this new reclassification of termite as a single family was not accepted by most other researchers since the current termite classification is almost universally admitted and used.

Indeed, the major termite lineages are already well defined at the family rank and large biological and economic literature has employed this system of names. One other problem of using the new proposed classification (termites within the order Blattaria) is that the relationships among the major cockroach lineages remain unresolved and robust inferences of relationships among all major lineages of Blattaria are missing.

Termites can be separated taxonomically using different features including external morphology, food and nest type, chemical and behavioral differences. For example, they are divided into wood litter or soil feeding as well as into dry wood, damp wood and subterranean termites based on their nest location.

More than 1,000 of the > 2,600 recognized species of termites are found on the African continent. Mound-building species of termites occur throughout most of the African landscape. Termite diversity in North Africa is low, with about 11 species, comprised of subterranean and drywood termites. The important genera are *Anacanthotermes* (Family Hodotermitidae), *Psamotermes* and *Reticulitermes* (Family Rhinotermitidae), *Amitermes*, and *Microcerotermes* (Family Termitidae), and several species of Kalotermitidae. Termites have been transported over much of North Africa over the millennia due to commerce and nomadic migrations.

The dry conditions throughout most of North Africa preclude dampwood termites. However, mound building termites do occur in East Africa, which has a rich termite

fauna with a notable abundance of species in the Macrotermitinae. The important genera in the forests include *Schedorhinotermes* and *Cubitermes*. In the savanna areas, Macrotermitinae, Termitinae, Amitermitinae and Nasutitermitinae are important taxa. Their biomass exceeds that of mammals in the same landscape.

Termite diversity in West Africa is similar to that in East Africa: mound building species dominate the landscape, although other subterranean and drywood termite species also occur. Important genera include *Ancistrotermes*, *Macrotermes*, *Odontotermes* (Family Termitidae, Subfamily Macrotermitinae), and *Microtermes* and *Cubitermes* (Termitidae: Termitinae).

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### Biographical Sketch

**Herbert J. Guedegbe** is a molecular microbiologist. He receives his B.Sc. and M.Sc. in Environmental Sciences respectively from Polytechnic school of Abomey-Calavi (Benin) and University of Paris XII (France), and a Ph.D from French Institute for Research and Development (Molecular Microbial Ecology). He is Associated Scientist at the Microbial Ecology Lab of Faculty of Agronomical Sciences in Benin, and his scientific interest includes the study of relationship between termites and their associated symbiotic flora. He also as interest on mycorrhizal fungi effects on soybean seeds. His research has been published in journals with worldwide audience such as *Mycologia* and *Mycological Research* and he is also reviewer of high-quality scientific journals such as *Microbial Ecology*. In addition to his scientific activity, he is also international consultant working for biotech and pharmaceutical companies. Dr. Guedegbe is currently working for a consulting firm as Expert of temperature-sensitive pharmaceutical products transportation. He is member of The Quebec Association of Microbiologists and The American Society of Quality.