Termite Tales: Unravelling the Secrets of Their Social Life and Reproductive Behaviour

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Abstract

Termites are among the most fascinating and ecologically significant insects in the world. Known for their complex social structures and architectural marvels, these creatures have intrigued scientists for centuries. While they are often considered pests due to their ability to damage wooden structures, termites play a crucial role in ecosystems, particularly through their contribution to soil health and nutrient recycling. In this article, we explore the unique social organization and reproductive behaviour of termites, shedding light on the intricacies of their colonies and the mechanisms that enable them to thrive.

The World of Termites

Termites are eusocial insects, meaning they live in colonies with a strict division of labour and cooperative care of their young. Alongside bees and wasps, termites are among the most advanced examples of social insects. However, while bees and wasps are more closely related to ants, termites are more closely related to cockroaches. This evolutionary connection becomes apparent when examining their social behaviour and ecological functions. Termites are primarily divided into higher termites (Termitidae) and lower termites. These groups differ in their habitat preferences and behaviours, but all termites share some common traits, such as their reliance on cellulose (plant fibre) for food. Cellulose is difficult to digest, but termites have symbiotic relationships with microorganisms in their gut, allowing them to break down this tough material. This makes them key players in the decomposition of organic matter, contributing to the nutrient cycles of the ecosystems they inhabit.

Life Inside the Termite Colony

A termite colony is a highly organized society consisting of different castes, each with specific roles. These castes can be divided into two main groups: sterile and reproductive castes. The sterile castes include workers and soldiers, while the reproductive castes include kings, queens, and supplementary reproductive forms.

- **Workers:** Workers make up the majority of the colony and are responsible for most of the tasks that keep the colony running smoothly. They build and maintain the nest, forage for food, feed other members of the colony, and tend to the young. Despite being sterile, workers play a vital role in ensuring the survival and growth of the colony.
- **Soldiers:** Soldiers are specialized for defending the colony from predators, such as ants and other threats. With their powerful mandibles and chemical defenses, they are well-equipped for combat. Like workers, soldiers are also sterile and depend on the workers to provide them with food.
- **Reproductive Castes:** The king and queen are the founders of the colony. The queen's primary role is to lay eggs, sometimes producing thousands of eggs each day. The king remains by her side throughout her life, continuously fertilizing her eggs. In addition to the primary reproductive pair, some colonies may also have supplementary reproductive, which step in if the king or queen dies or becomes unable to reproduce.

Communication and Cooperation

Termites rely on chemical signals called pheromones to communicate with one another. Pheromones play a key role in regulating the behaviour of the colony, from coordinating foraging efforts to signalling danger. For example, trail pheromones guide workers to food sources, while alarm pheromones alert the colony to threats. Social cooperation in termites extends beyond simple communication. The division of labour within the colony ensures that all tasks are carried out efficiently, from food gathering to defense. Termites also engage in cooperative brood care, with workers tending to the eggs and larvae, ensuring the next generation of termites develops in a protected environment.

Termite Queens

The reproductive tract of termite queens is characterized by paired ovaries that grow significantly after swarming. Queens have a high demand for eggs, and their reproductive capacity largely determines colony size. Termite queens exhibit extreme physogastry, particularly in species like *Nasutitermes corniger*, where the mature queen's mass can increase

substantially compared to the initial dispersing female. Queens store sperm in spermathecae, which vary in size and shape among species. The spermathecae have secretory cells that help maintain sperm viability. Unlike social hymenopterans, termite alates do not copulate before dispersal, as no sperm is found in the spermathecae of female alates.

The Remarkable Role of the Queen

The termite queen is perhaps the most fascinating member of the colony. Her primary role is reproduction, and she is capable of producing massive numbers of offspring. In some species, the queen's abdomen becomes greatly enlarged as she ages, allowing her to produce more eggs. A well-established termite queen can live for decades, continually laying eggs and ensuring the colony's survival. In some cases, if the queen dies or is no longer able to reproduce, the colony can produce supplementary queens to take her place. These queens are capable of reproducing but do not reach the same size or reproductive output as the primary queen.

Mating Flights and Pair Formation

Termites undergo mating flights that consist of a dispersal phase and a pair formation phase. During the dispersal phase, sexual leave their parental colony. In the pair formation phase, some species exhibit 'calling' behaviour, where one or both sexes release pheromones to attract mates. After pair formation, termites engage in 'tandem running,' where the male follows the female as she searches for a nesting site. This behaviour may be part of mate selection, although the evolutionary significance of tandem runs and mate choice in termites remains unclear. In most termite societies, a single pair of reproductive heads the colony, with additional sexual often being rejected or killed. However, some species exhibit facultative polygamy, where multiple primary queens and/or kings can occur, usually arising from the merging of young colonies or the construction of nuptial chambers by multiple alates. Research has shown that single pairs generally perform better in colony establishment and offspring production compared to groups with multiple reproductive.

Copulation and Sperm Management in Termites

Copulation Behaviour

Unlike eusocial hymenopterans, termite copulation occurs after colony establishment and within the safety of the nest. Courtship behaviours, such as mutual antennation and grooming, precede copulation, which typically involves the paired termites aligning in an opposed position. Although the duration of copulation can range from 30 seconds to 10 minutes, and may happen multiple times within a 24-hour period, detailed information on the evolutionary significance of these behaviours and copulation duration remains limited. Observations from various studies suggest that copulation frequency and duration can vary, but data on mature pairs are still lacking.

Sperm Transfer, Storage, and Utilization

During copulation, sperm is transferred to the female's outer genital chamber. In termites like *Reticulitermes hesperus*, sperm is found embedded in a matrix within the genital chamber, though the composition and origin of these secretions are not fully understood. The sperm eventually moves to the spermathecal duct and spermatheca, but termites generally have less capacity for sperm storage compared to eusocial hymenopterans. In species such as *Macrotermes michaelseni* and *Coptotermes formosanus*, the production of fertile eggs by the queen significantly decreases within a few months after the king's removal, indicating limited sperm storage capability and possible sperm senescence.

Neotenic Reproduction and Colony Longevity

Replacement of Primary Reproductive

Neotenic reproduction, or the ability of offspring to reproduce within the parental nest, is observed in about 63% of lower termite genera and 13% of higher termite genera. Evidence suggests that conflicts and competition may occur among potential successors, as seen in *Cryptotermes secundus*. The number of reproducing neotenics and their contribution to new offspring vary widely, with some species exhibiting sexual selection among neotenic individuals.

Colony Longevity and Inbreeding

While some basal termite species can have multiple neotenics producing more eggs than a single primary queen, the colony's lifespan is limited by the size of its nest and food source. Most subterranean termite colonies cannot survive the loss of their original reproductive pair, with neotenics primarily supplementing rather than replacing the primary reproductive. Additionally, inbreeding is avoided in some species like *Reticulitermes* through asexual queen succession, where the king mates with clones of the deceased queen. However, the prevalence and evolutionary significance of this behavior across termites are not yet fully understood.

Reproductive Replacement and Colony Survival

The death of primary kings and queens often leads to colony collapse in higher termites. Although some species can develop replacement reproductive,

such as ergatoid or nymphoid individuals, these replacements typically have lower fecundity compared to the primary pair. The survival of colonies with replacement reproductive varies, and further research is needed to understand the mechanisms and fitness implications of reproductive replacement

Nuptial Flights and the Formation of New Colonies

One of the most dramatic events in the life cycle of termites is the nuptial flight, during which winged reproductive termites, known as alates, leave their parent colony to establish new colonies. This event occurs when the colony reaches a certain size, and it usually happens once or twice a year, often after rainfall. During the nuptial flight, thousands of alates take to the air in a synchronized swarm. The flight serves two purposes: dispersing the alates to new locations and facilitating mate selection. Male and female alates pair up during the flight and then shed their wings after landing. Together, they find a suitable location to start a new colony, where the female becomes the queen and the male becomes the king. The mating behavior of termites is unique in that it often involves lifelong pair bonds between the king and queen. Unlike many other insects that mate only once, termite kings and queens continue to reproduce together for the duration of their lives, with the queen laying eggs throughout her life. In some species, a single queen can lay thousands of eggs each day, ensuring the rapid growth of the colony.

Conclusion

Termites may often be viewed as pests, but their complex social organization and reproductive strategies are a testament to the intricacies of the natural world. By understanding the dynamics of termite colonies, scientists can gain valuable insights into social behaviour, cooperation, and communication in animals. Moreover, termites play an essential role in ecosystems by breaking down cellulose and recycling nutrients, making them vital to the health of many habitats around the world. As we continue to study termites, we can better appreciate their unique contributions to both natural systems and human societies. Whether building towering mounds in Africa or quietly foraging beneath our homes, termites offer a fascinating glimpse into the power of cooperation and specialization in the animal kingdom

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