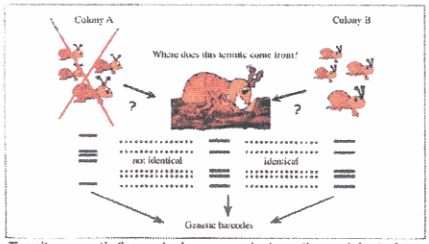
What can molecular biology tell us about termites?



Termites genetic 'barcodes' can reveal where they originate from

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Improving ways of managing termites requires a thorough understanding of the biology of the termite species.

However, a challenge to researchers has always been that subterranean termites live a cryptic life underground, which makes it difficult to spy on their biology. Fortunately, the genetic material of termites (DNA), can tell us much of the story of their history and life style, if we can read the messages. Termite DNA is passed from generation to generation and, like us, each termite gets half of its DNA from the father and half from the mother. Thus, DNA contains information about ancestry as well as about relationships among individuals.

Molecular genetic techniques used in termite research involve enzymatic digestion of their DNA, separation of the DNA fragments through gel electrophoresis, and hybridization with labeled probes to make the patterns visible, as well as gene sequencing or amplification of certain regions of the DNA through polymerase chain reaction (PCR). These methods yield distinct banding patterns representing the sequence of DNA building blocks, which reflect the identity of termites and a large part of their biological features. Basically, termites come with individual "barcodes" just like canned goods in the supermarket, and these molecular genetic techniques make the codes visible. These "codes" or - in more scientific terms - genotypes are unique to each individual termite, and also indicate their membership in a particular colony (family) and regional population.

Comparing genetic similarities between termite colonies to geographical distances tells how termites spread throughout a region: Termites are weak fliers. Therefore colonies close to each other should be more closely related to each other than to colonies from distant locations. However, we did not find such a relationship between geographic and genetic distance among *Coptotermes formosanus* colonies in Hawaii. This provides evidence that the Formosan subterranean termite covers large distances with human help, by hitchhiking in wooden materials. We are now following this approach on a global scale to shed light on the sources, methods and speed of Formosan subterranean termite dispersal around the world.

On a smaller scale we use the individual-specific and colony-specific genotypes ("barcodes") to assign termites to their home colonies and to "tag" colonies prior to elimination by baiting so that we can study subsequent termite re-invasion (see picture). Comparing the genotypes of colonies tells us if reappearing termites are remnants of the same colony or invaders from adjacent colonies.

The frequencies of genotypes among the offspring (workers and soldiers) of a colony reveal the number of kings and queens that are actively reproducing in the colony, which can almost never be counted directly. The relatedness among the offspring tells us whether a colony is headed by unrelated kings and queens (the colony founders) or by related, inbred reproductives (replacement reproductives). The presence of multiple kings and queens located in different parts of the colony could lead to separate groups of more closely related individuals within colonies. This is important to investigate, since it could influence the spread of bait toxicants through the colony.

In conclusion, understanding the genetic structure of termite populations and colonies sheds light on invasion and dispersal of termites on both global and local scales. In addition, molecular techniques help to identify and characterize colonies, as well as define the colonies' social and spatial structure. All this information is extremely valuable to help improve quarantine and termite control. This is not yet the Termite Genome Project - but molecular biology tells a good deal of the termites' story that we would never have otherwise discovered.