BioMEDIA ASSOCIATES LLC
TERMITES
The secret queens of woodlands

Study Guide
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Supplement to Video Program

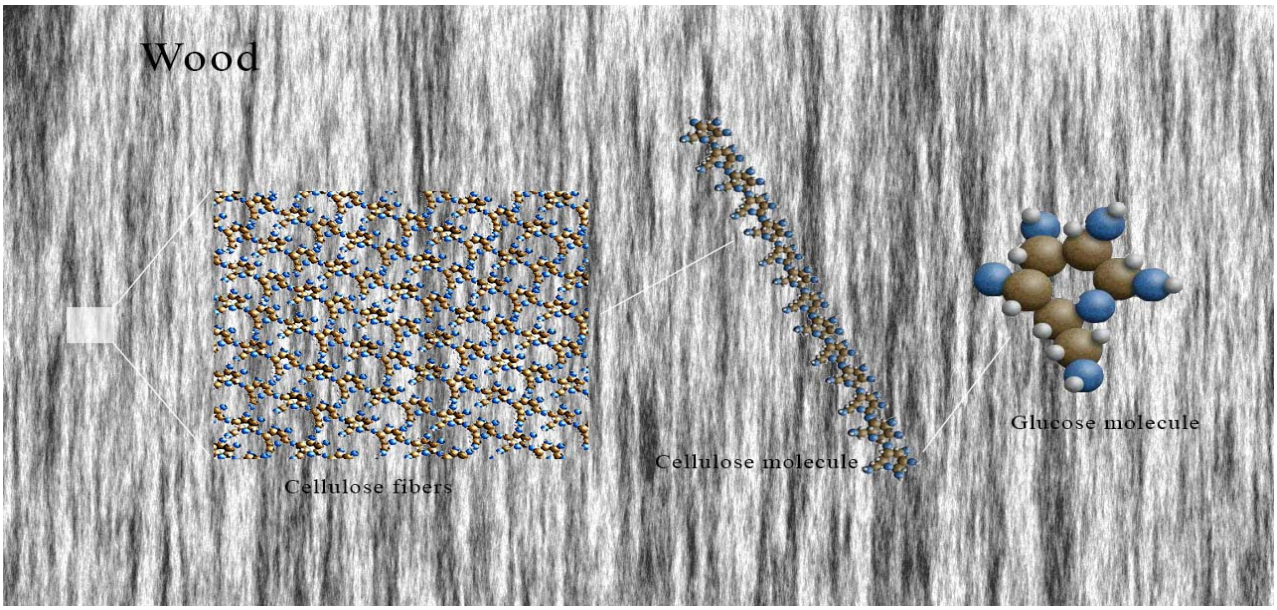
Distributed by tropical, subtropical and temperate regions of the planet, between 47º north and 47º south , termites are an excellent example to understand the way in which Life has evolved on our planet by establishing complex relationships both interspecific and intraspecific.

The forests. Energy accumulators.

One of the main characteristics of forests, apart from his work as oxygenators of the atmosphere, is its enormous capacity to store energy.

Trees, through photosynthesis, store energy in the form of wood in their trunks, roots and branches.

Wood is composed mainly of cellulose fibers. Cellulose is a macromolecule formed by the join of a large number of glucose molecules. And glucose is one of the most important molecule in the metabolism of all animals, including our own.



Cellulose is the most abundant biomolecule in the planet, and the amount of energy stored in 1 kg of cellulose was estimated to be around 4,000 Kcal, very similar to the energy amount of the sugar that sweetens our food.

If cellulose is so abundant and so energetic, why we do not eat it?. If wood is composed mainly of cellulose, why we do not eat wood? Why we do not eat trees?.

The answer to these questions is the same in all three cases: because we cannot digest it.

Since we are unable to digest cellulose, it has no any food value for us, but other organisms are able to digest cellulose and can feed on wood.

On the one hand, bacteria and fungi stand out among this group of organisms. For this reason it is common to see mushrooms growing on decaying tree trunks and branches lying on the forest floor.

On the other hand, very few animals are able to feed on wood.

Some beetles, like longhorn beetles, also known as longicorn beetles, feed on the wood during their larval development.

However, the animals most efficient at digesting wood are termites.

Some questions:

Why is the glucose molecule so important for the metabolism of all animals?
Could you name some other animals capable of feeding on wood, apart from termites?

What are termites?

Termites are insects belonging to the order of Blatodea, specifically the suborder Isoptera.

In many places they are called "white ants", but this is a mistake, because termites and ants are phylogenetically quite distinct species.

Actually, termites are more closely related to cockroaches than to ants. In fact, we can say that termites are small cockroaches that are specialized to feed on wood.

The oldest known fossil termite dates back to the Cretaceous period, about 140 million years ago, and since then they have diversified into about 3,000 species (some already disappeared). All of them are classified into 12 families.

Of greater interest to us, mainly because of the damage their activity causes to our wooden structures are subterranean termites of the genus *Reticulitermes*, belonging to the family *Rhinotermitidae.*

Some questions:

Can you identify the morphological differences between termites and ants?
What other insects you think are most directly related to termites, apart from cockroaches?

Why termites can feed on wood?

The termites of the genus *Reticulitermes*, also known as subterranean termites, are voracious wood-eaters.

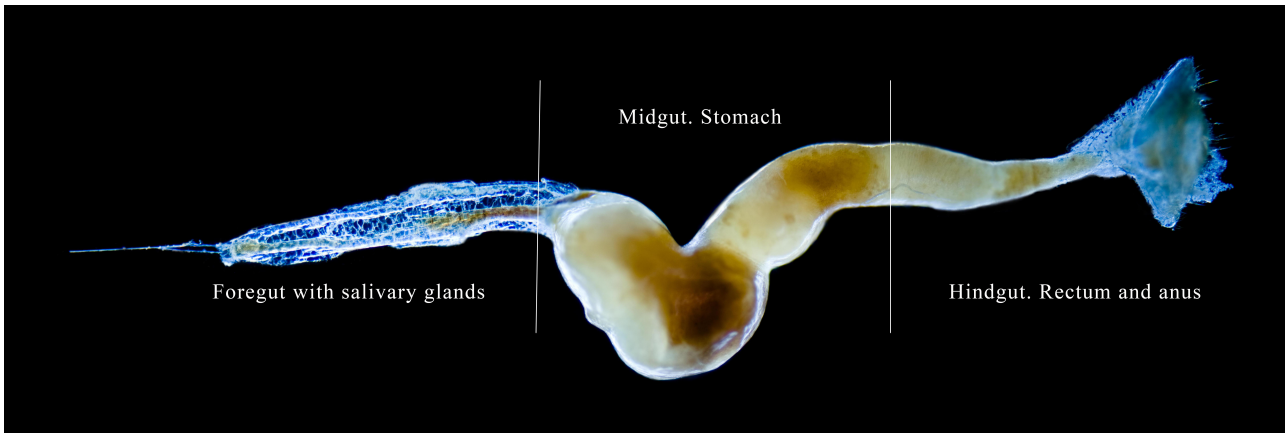
They attack wood from underground, where they have set up their nests and start to eat the trunks and branches from inside, creating hidden galleries and chambers.

Similarly they infest our buildings. In fact, the damage caused by termites is estimated at several million dollars a year.

But, why can termites eat wood? What makes them different from most animals?

The "secret" of termites resides inside them, in their digestive system.

The digestive system of a termite is like a tube that runs through her body from the mouth to the anus. It is divided into three parts:

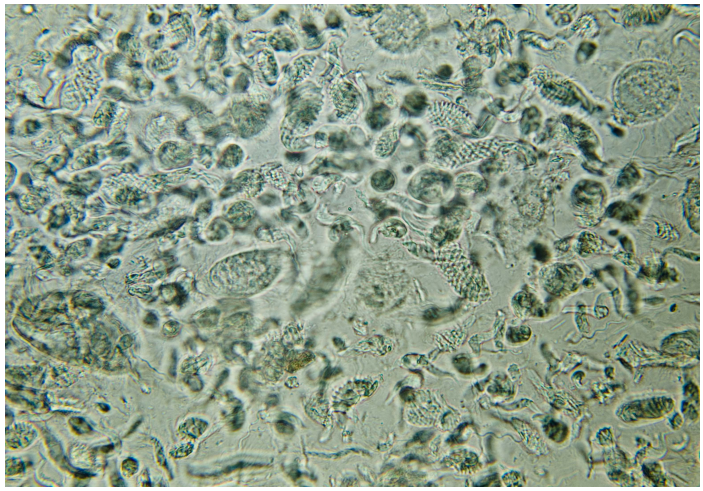


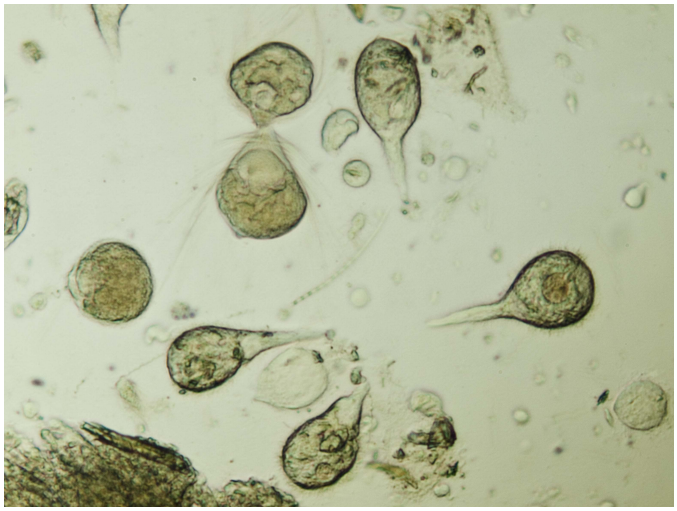
The anterior part, closest to the mouth, is long and includes enormous salivary glands. The secretions of these glands begin to soften wood chips cut off by the jaws before they enter the stomach.

The posterior part, farthest from the mouth, is also elongated and ends at the anus, which is the hole through which termites expel feces.

Between both parts is located the stomach, the central segment of the digestive system and of the termite. It is precisely where the digestion of wood actually takes place.

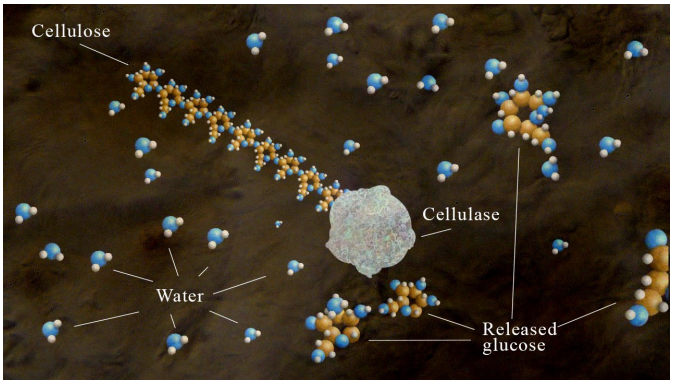
However, within the stomach of a termite of the genus *Reticulitermes* are not only wood chips, but also a huge population of protozoa, unicellular organisms that have established a close symbiotic relationship with the termite.





Scientists have described about 20 different species of these protozoa inside the subterranean termites, and all of them are actively involved in the digestion of wood.
In fact, it is the protozoa, not the termites themselves that digest cellulose.

These protozoa are capable of synthesizing an enzyme called cellulase that is responsible for breaking the cellulose chains and releasing their components, glucose molecules, by a chemical reaction called hydrolysis. Termites thus can absorb the resulting glucose molecules for use in their own metabolism.

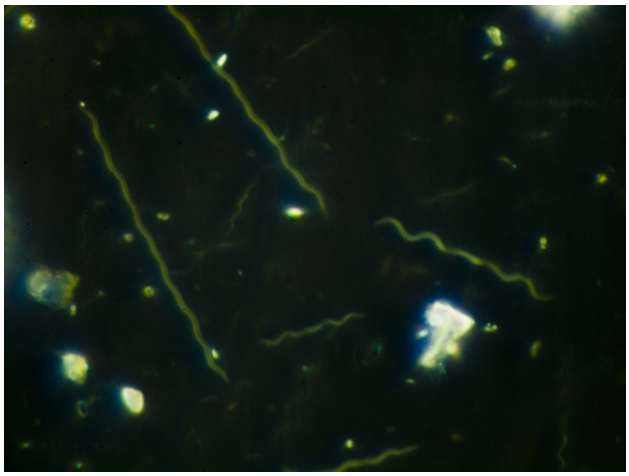


However, the secret of termites is more complex.

Within each of these symbiont protozoa live large numbers of bacteria that are also involved in the digestion process, and that are able to produce other substances which are important for nutrition of both termites and symbiont protozoa.

Seen this way, a termite looks a lot like a traditional "Russian Doll". Some organisms (bacteria) that live inside other organisms (protozoa) that, in turn, live inside other organisms (termites).

But not all bacteria that live inside a termite do so within protozoa.
There are many free-living bacteria in the stomach fluid. And of them all, the most abundant are spirochetes.



Spirochetes are elongated bacteria having undulating shapes and which can swim freely. Their role in the process of nutrition of termites is related to the metabolism of nitrogen.

Termite diet, based on cellulose, is rich in carbon (each glucose molecule has six carbon atoms) but very poor in nitrogen. And nitrogen is essential for the synthesis of important molecules such as nucleic acids and proteins.

It is thanks to the activity of this complex web of relationships between termites, symbiotic protozoa and bacteria that wood that was on the forest floor ends recycled. And all the energy and matter accumulated is reintroduced into the cycle of life on the planet.

Some questions:

Can you give some other examples of symbiosis in nature?
Can you explain the difference between a symbiont and a parasite?
Why are spirochetes that live inside the gut of termites so abundant and important?

How do these termites live?

Subterranean termites spend most of their lives inside the galleries. There they find protection against possible dangers from outside and enjoy a more or less constant environment which moderates variations of temperature and humidity.

The nests of these termites often go unnoticed because they do not extend above ground. These termites do not build the spectacular structures that can be observed in some tropical regions of Australia, South America or Africa, but create a complicated network of underground tunnels that can extend for several thousand square meters.

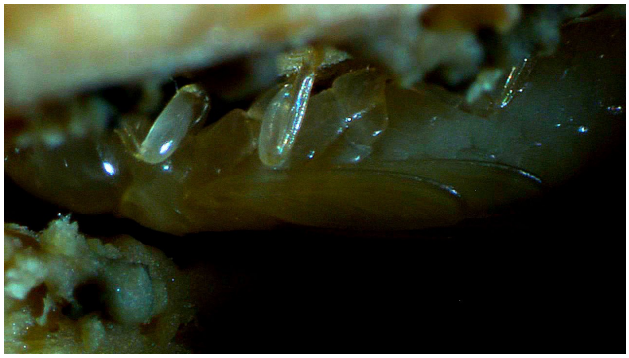
Several million individuals can live in this underground "city", all belonging to the same population, and all organized into a rigid society divided into castes.

The largest caste is that of the workers. Workers are responsible for carrying out almost all tasks within the termite nest. They are primarily responsible for the construction and maintenance of galleries. And they are also responsible for feeding members of other castes and care for immature individuals during their stage of development.

Their jaws are strong and tough, and with them termites chip the wood and transport materials necessary for the construction of the galleries and chambers of the nest.

In the role of feeders of their sisters of other castes, workers can use two different techniques.
The first is called estomodeal trophallaxis. In this case the workers regurgitate part of the food and offer it to the other termites.

The second technique is called proctodeal trophallaxis, and it consists in the secretion of a special type of excrement that other termites use as food. These special droppings consist not only of semidigested materials, but also a lot of symbiotic protozoa. And that has a special importance for developing termites, allowing them to maintain their own symbiont communities needed to digest cellulose.



Another caste within this society includes secondary reproductive individuals. Their appearance is similar to that of the workers, but when on their backs you can observe rudimentary wings.

These secondary reproductive termites will be responsible for the survival of the colony in the event the population is separated by some accident. In these circumstances, these individuals are able to lay eggs and continue with the growth of the colony.

The third caste is that of the soldiers.

The most prominent feature of their anatomy is their big, hard head, also provided with a pair of large, sharp jaws.
They are responsible for protecting the colony from attack by an enemy. But those huge jaws prevent them from chewing wood, so they must be fed by the workers.

Finally, the last caste is that of the primary reproductive termites, known also as "alates".

Its appearance is very different from that of the other members of the colony.
They are dark, almost black, and have two pairs of large, delicate and translucent wings.

They are responsible for colonizing new territories and creating new colonies. Their emergence occurs massively, usually only once a year.

It is in those moments that they are vulnerable to attacks from predators, but the huge number of individuals leaving the nest simultaneously acts as a defensive strategy, because the greater the number in the swarm the greater are the chances of survival of any one of them.

Males and females leaving the termite nest perform what is known as the "nuptial flight", in which individuals of opposite sexes find each other and mate. Once the couple has been formed, both individuals drop back to the ground, where they lose their wings and begin the formation of a new colony.

Some questions:

What benefits can being strictly divided into a society of castes bring to the colony?
Is there any advantage in the fact that all reproductive forms leave the nest at once?
Team working of termites: is it the result of instinct or intelligence?

Species appearing in the program

Roe deer *(Capreolus capreolus)*

Golden Oriole (Oriolus oriolus)

Black starling *(Sturnus unicolor)*

Blue tit *(Parus caeruleus)*

Sardinian warbler
(Sylvia melanocephala)

Great Spotted Woodpecker
(Dendrocopus major)

Short-toed Tree Creeper
(Certhia brachydactila)

Stonechat *(Saxicola rubetra)*

Robin *(Erithacus rubecula)*

Wildboar *(Sus scrofa)*

Syrphid fly (Sirphidae)

Red ant *(Formica rufa)*

Red deer *(Cervus elaphus)*

Gatekeeper (*Pyronia* sp.)

Longhorn beetle (*Rhagium* sp.)

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