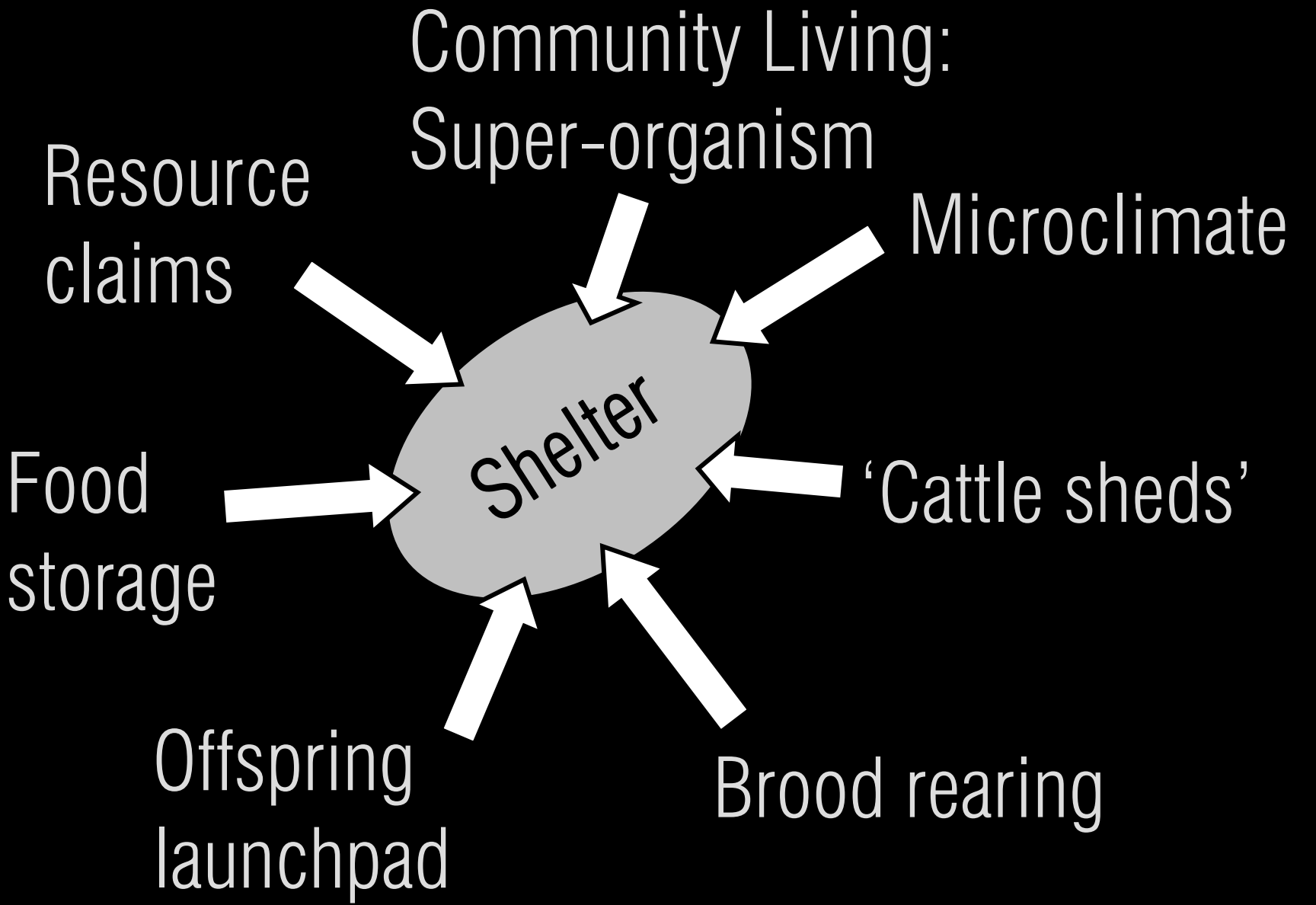
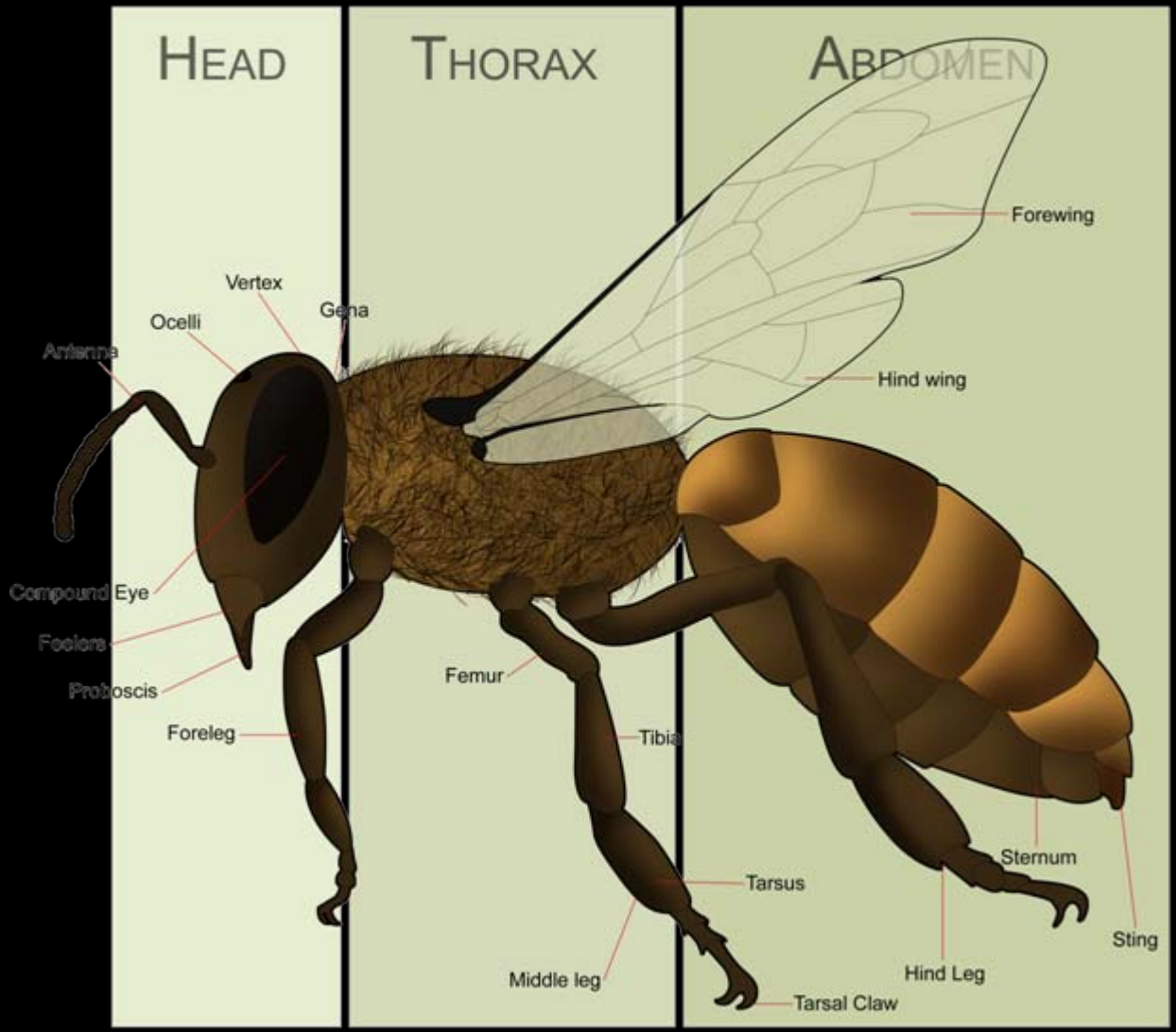
Insects + Architecture

Insectiture

But why build?


Community Living:
Super-organism
Resource
claims
Microclimate
Shelter
Food
storage
‘Cattle sheds’
Offspring
launchpad
Brood rearing

The Honeybee



Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Subclass:	Pterygota
Infraclass:	Neoptera
Superorder:	Endopterygota
Order:	Hymenoptera
Suborder:	Apocrita
Family:	Apidae
Subfamily:	Apinae
Tribe:	Apini
Genus:	*Apis* Linnaeus, 1758

Honey bees are a subset of bees, primarily distinguished by the production and **storage of honey** and the construction of **perennial, colonial nests out of wax**.

The Bee and the Hive…

Young worker bees clean the hive and feed the **larvae**. They secrete royal jelly- which is protein rich- from glands on their **heads**

When these glands begin to **atrophy**, they start building comb walls using **wax** from glands on their **abdomens**.

They graduate to within colony tasks such as **receiving** pollen and nectar from foragers and guarding the hive

Start flights for foraging, the **wax glands** atrophy. Remainder of the life is as a **forager**.

Ingredients for the perfect Beehive…

Beeswax: Is a natural was produced by the glands of young worker bees (these glands atrophy with age when the worker's flights begin). This wax is initially transparent, but becomes opaque after the bees chew on it. It further gains a yellow color because of pollen and propolis. To produce this wax, a bee must consume eight times as much honey by mass (hence beekeepers usually return the wax after 'robbing the bees').

**Beeswax is commercially used as an ingredient for moustache wax.*

Propolis: Is a resinous mixture collected by bees from tree buds, sap flows and other botanical sources. It is used as a sealant for unwanted small gaps by the bees. Propolis increases the structural stability of the hive. Propolis also helps 'mummify' objects which may putrefy inside the hive. Although composition of propolis is highly case specific, it may exhibit antifungal and antibacterial properties.

Pollen: Palynivores eat the fine powder consisting of pollen grains thus consuming proteins and amino acids. This is carried in the pollen baskets and is necessary for brood rearing.

Honey: Is a sweet and viscous fluid produced by honeybees and derived from floral nectar. Bees store this as a source of energy during scarce periods. The low water content, and high sugar concentration prevents fermentation and thus has a long shelf life (honey residues have been found in the pharaoh's tombs too!).

Bees: A single Queen bee, a seasonally variable number of drone bees to fertilize new queens, and some 20,000 to 40,000 sterile female worker bees.

Site Preferences:

Natural nesting sites selected by honeybees are '**hollows**' of different sorts. Normally, a cavity about 50 litres in volume is preferred (less than10 lts or more than 100 lts usually avoided).
The hive is normally situated at a height between **1m-5m** from the ground. **South** facing entrances are preferred. There is no particular bias towards any tree species.

Zoning:

Honey

↓

Pollen storage cells

↓

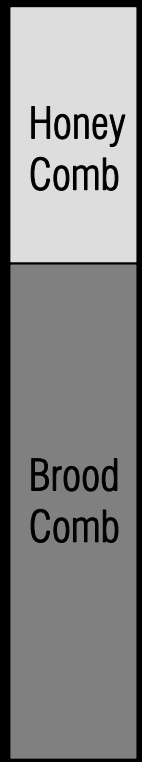
Worker brood cells

↓

Drone brood cells

↓

Queen cell



Each cell is a standardized unit only slightly larger than the bee's body. The wax is paper thin. No reinforcing strands or insulation thickens it. Every cell shares a vertical wall on either sides with adjacent cells. The low 'gable roof' serves as the floor material for two adjacent cells above. The floor also seems to have a 'drainage channel' which redirects the liquids to the far end due to the slope.

Brood comb: Nursery for the Immature Bees

Eggs and Larvae inside the wax cells

Brood comb Section with eggs

Services:

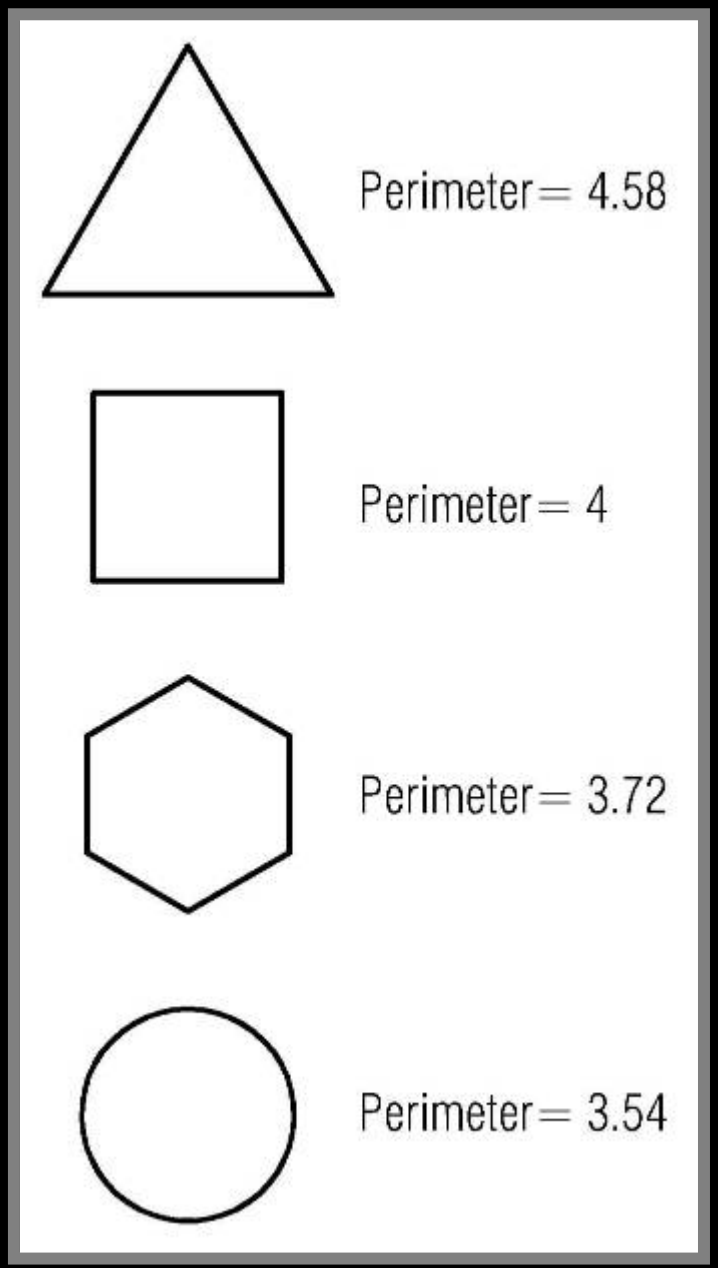
Each Honeybee contribute **body heat** for the hive, generating **1/10th of a calorie** per minute. A human body emits about 1200 calories per minute (about the same as a 100 watt bulb). Thus a hive full of bees can produce as much heat as **four people**.

Thus an **artificial summer** is maintained inside the hive all year round. For the wax-making bees to secrete wax, the ambient temperature in the hive has to be **33 to 36 °C.** This unreal summer also hastens the **digestive** and **growth** processes of the immature bees while hurrying the **evaporation** of water from the honey that is ripening in the cells.

Bees leave few openings between the comb and the outside world through which heat may enter or escape or so might other creatures. Every space more than a centimeter is filled with **wax**. Smaller cracks are filled with **propolis**. Bees only cool their hive when temperatures reach 35 deg Celsius or above. Workers dissipate their energy away from the brood while foraging. Residents propel outdoor air into and through the nest.

When temperature falls around 10 deg Celsius, the bees cluster around the queen and keep her warm at about 20 deg Celsius.

For a Unit Area…

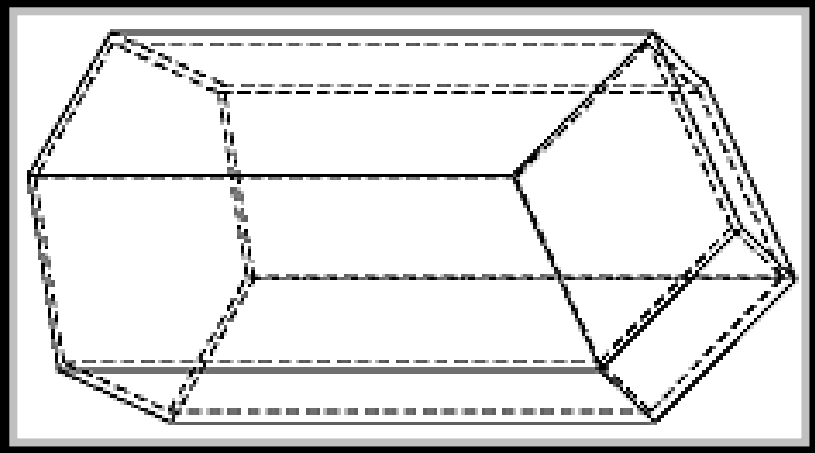


A Circle shall consume the **least** amount of material with the **maximum** capacity

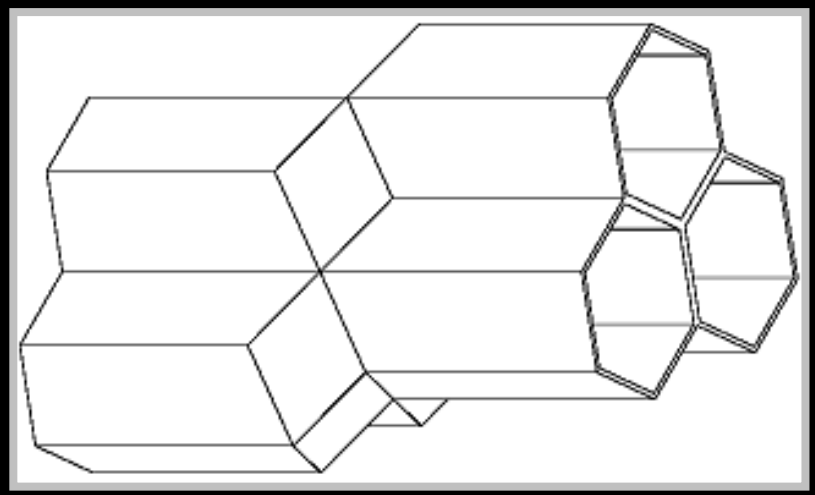
But a pattern of circles shall be **wasteful** because of the **negative spaces** created

So a pattern consisting of **Triangles** or **Squares** shall utilize the given area **effectively**

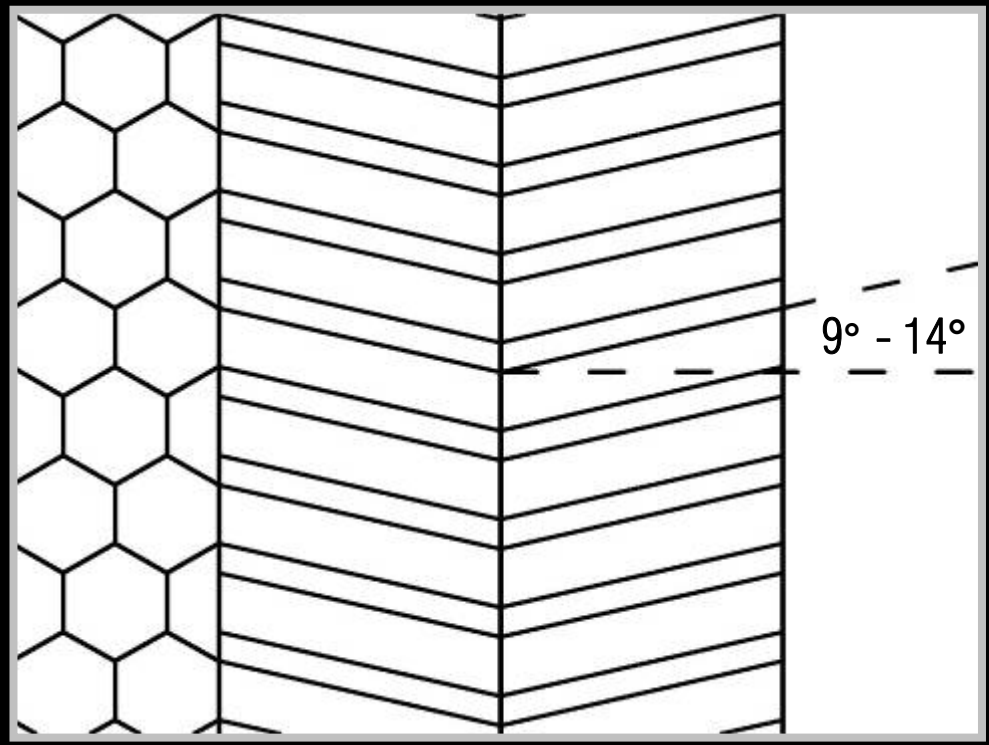
But a **hexagon** shall have the **shortest circumference** as compared to the rest



The 3 Dimensional Geometry



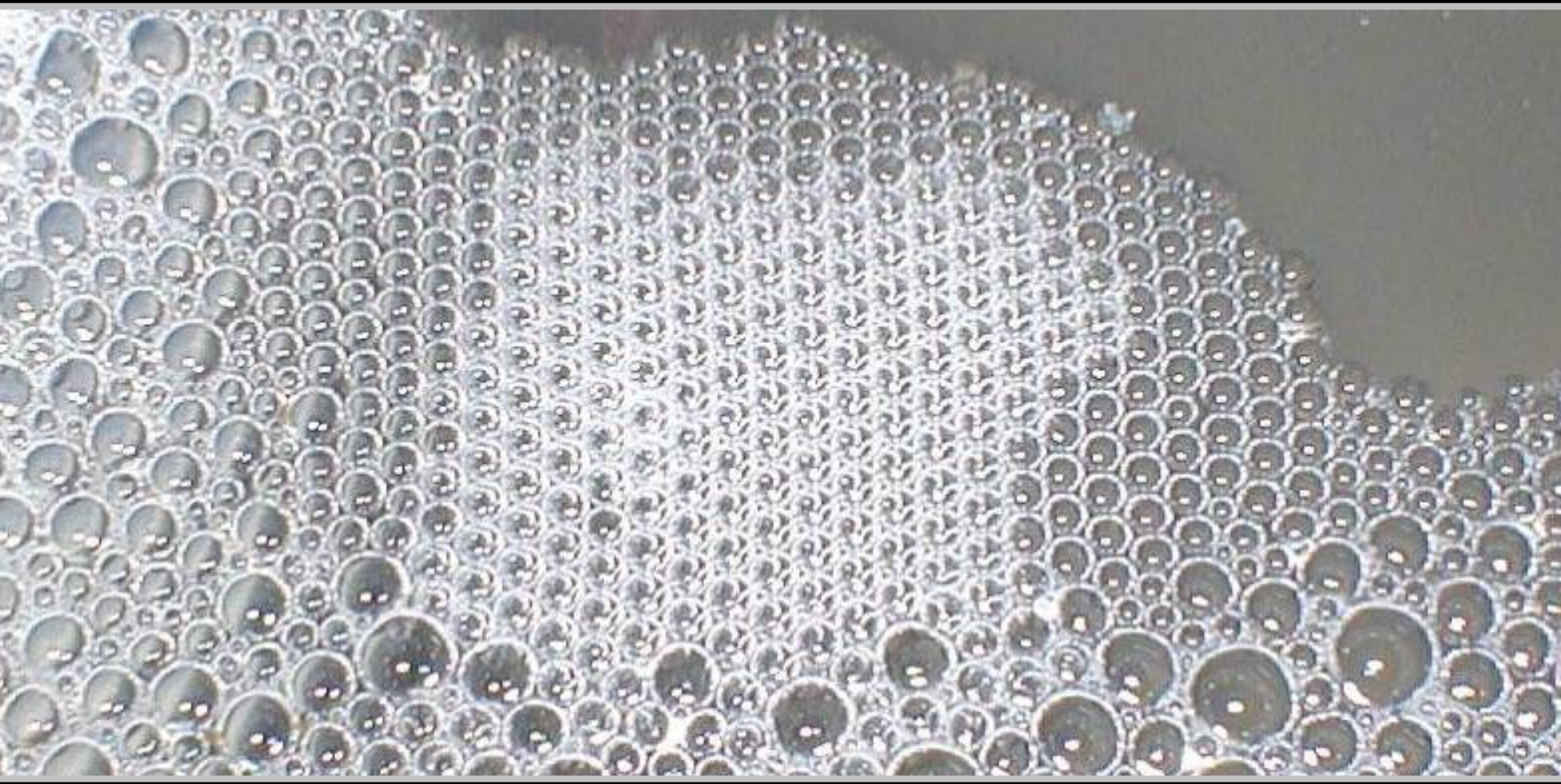
Opposing layers fit together



The Section:
Gently Sloping Cells

** There are deviations of a few percent from geometrical perfection. It is human to err.*

So are bees endowed with “geometrical forethought” and do they really make efficient use of available resources?

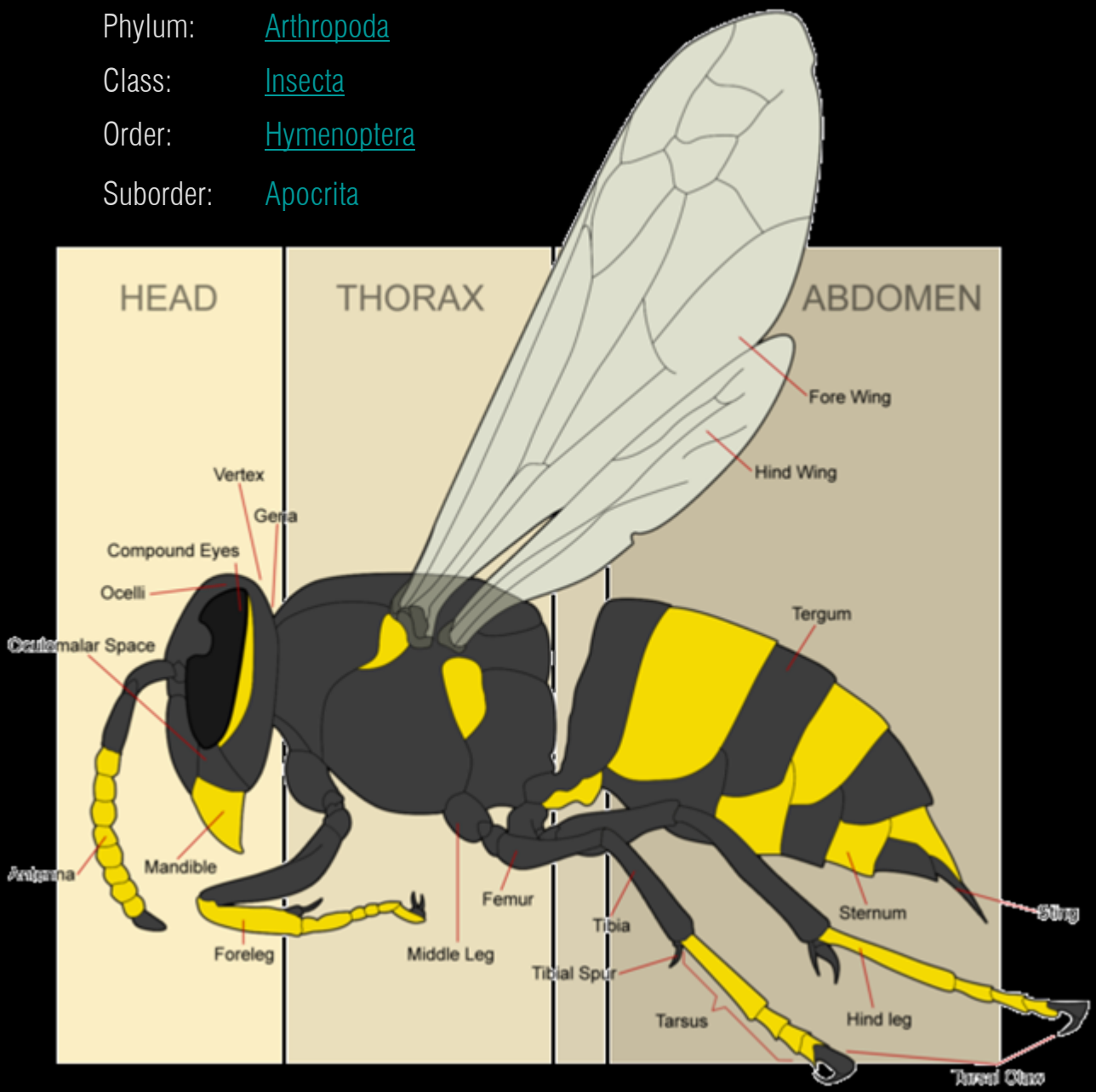


Or is it a result of simultaneous community construction?

At any rate. . . .

The Wasps

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Suborder: Apocrita



Wasps may be **Social** or **Solitary**. Adult solitary wasps generally live and operate alone, and most do not construct nests, all adult solitary wasps are **fertile**.

By contrast, social wasps exist in **colonies** numbering up to **several thousand** strong and build nests—but in some cases not all of the colony can reproduce. In the more advanced species, just the wasp queen and male wasps can mate, whilst the majority of the colony is made up of **sterile** female workers.

The type of nest produced by wasps can depend on the species and location. Many social wasps produce **paper** pulp nests on trees, in attics, holes in the ground or other such sheltered areas with access to the outdoors. By contrast solitary wasps are generally **parasitic** or **predatory** and only the latter build nests at all.

Unlike honeybees , wasps have no wax producing glands. Many instead create a paper-like substance primarily from **wood pulp**. Wood fibers are gathered locally from weathered wood, softened by chewing and mixing with **saliva**. The pulp is then used to make combs with cells for **brood rearing**. More commonly, nests are simply **burrows** excavated in a substrate (usually the soil, but also plant stems), or, if constructed, they are constructed from mud.

The strength of paper depends largely upon the **length** of the fibres of which it is made. Wood grain might be joined lengthwise or can be cut into **sawdust**. **Saliva** is used to hold the material together and sometimes to **varnish** it too. All nests are able to **resist moisture** to a large degree. Wasp paper may generally be greyish in colour because of the weather **worn** wood. Paper wasps secrete a chemical which **repels** ants, which they spread around the base of the anchor to prevent the loss of eggs or brood.

Mud dauber is a name commonly applied to a number of wasps from either the family Sphecidae or Crabronidae that **build** their nests from **mud**.

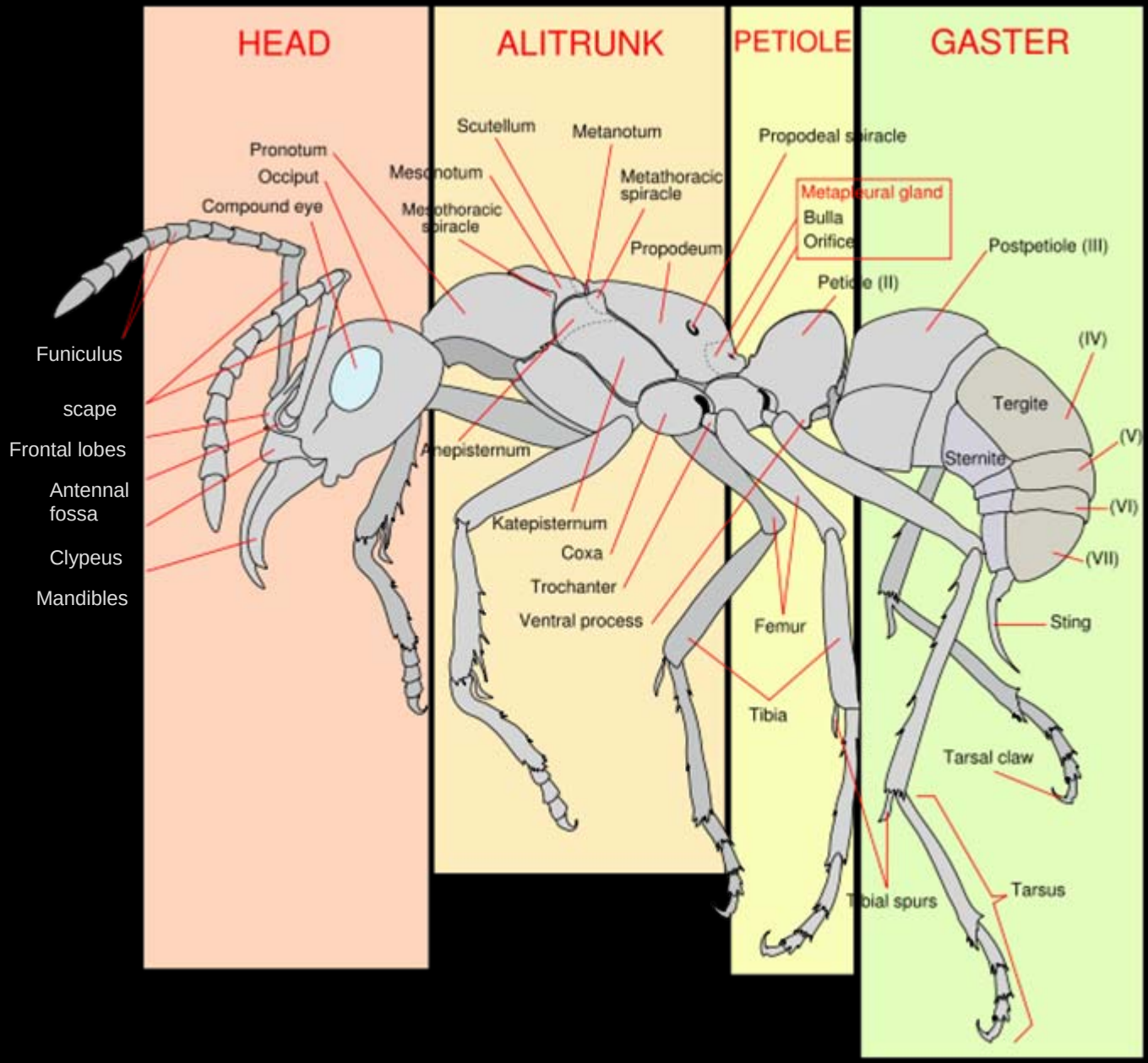
The **organ pipe mud dauber** (*Trypoxylon politum*) is a type of wasp in the family Crabronidae. They are fairly large wasps, shiny black with **pale hind tarsi**. Male organ pipe mud daubers are among the few male wasps of any species to stay at the nest. A male "stands guard" (to prevent theft of prey or nest materials, as well as to ward off parasites) while a female is away collecting spiders. Mating typically occurs on her visits to the nest. They typically build their nests in sheltered locations, and large **aggregations** may form with dozens to hundreds of nests in a small area.

Container..

Contents…

which brings us to..

The Ants



Family: Formicidae

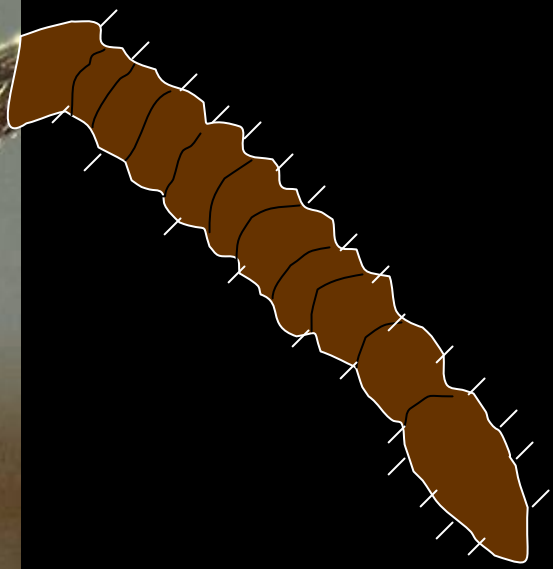
Subfamily: Myrmicinae

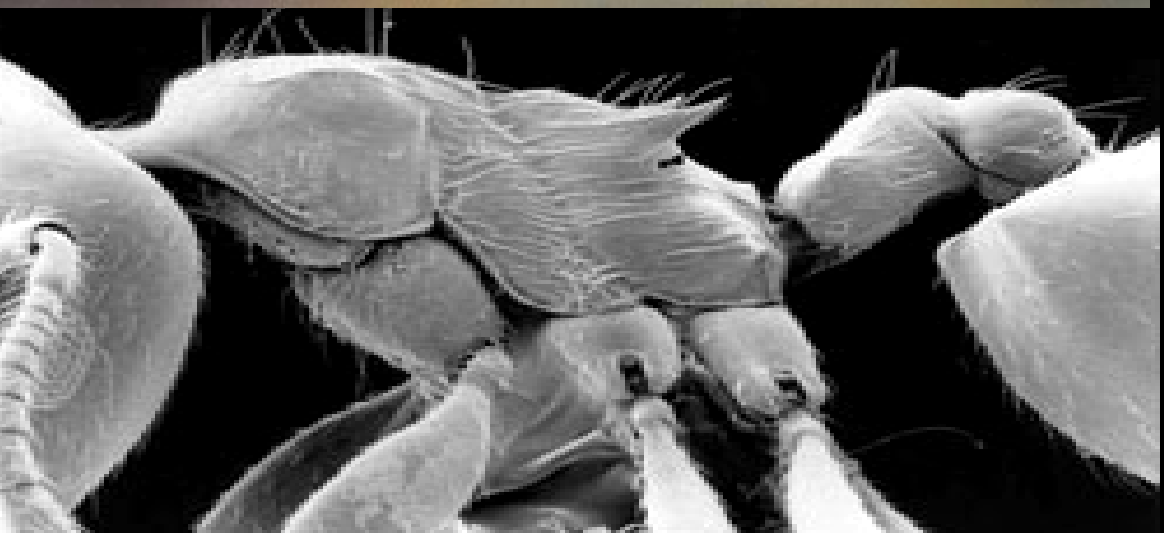
Genus: Crematogaster

Crematogasters are also known as **Pagoda** ants or **Acrobat** ants. They are common in temperate and tropical habitats. These are small to medium sized ants, generally 2.6 to 3.2 mm long. They have very **shiny** bodies that are variable in color from light red to brown or black. They are found on forest trees especially on plants with spikes and thorns.

The final segment, or **gaster** looks **heart shaped** when looked at from above, which is a distinctive feature. Acrobat ants are '**shiny**' in appearance.

Acrobat ants get their name from the habit of holding their **abdomen above** their **thorax** when the workers or the colony are **disturbed**.





The antennae are **11** segmented (including the scape). The **petiole** is low and rounded and lacks a node on its upper surface. The **postpetiole** is attached to the upper surface of the gaster. The nature of the attachment of the postpetiole to the gaster is highly distinctive and will separate these ants from all others.

Like all ants, this species has a complex life cycle developing from **eggs** into white legless **larvae** then **pupae** before emerging as adults. Development from egg to pupa takes place within the nest and immatures are rarely seen. Like all ant species, acrobat ants produce winged individuals known as **swarmers**. Swarmers are **fertile** adult **males** and **females** whose only function is to reproduce and found new colonies. They do not forage for food, bite, or sting. The males (drones) and females (queens) emerge, take flight, and mate while in flight. The females then land, shed their wings and seek soft soil in which to create a nest. The males die shortly after mating.

Crematogaster ants construct **pagoda** like nests on trees made of soil containing **decaying organic matter**.

Zoning:

These ants may be found both indoors and outdoors. They will not colonize wood that is in sound condition, but frequently nest in **dead** or **decaying** wood. Outdoors they are frequently found nesting in logs, stumps, and hollow tree cavities. They also nest beneath tarps, leaf litter, stones, or anyplace where the soil is likely to be **damp**. The nesting capabilities of acrobat ants often depends on the activities of **cavity-excavating insects**

They also build nests at a height of 2.5 ft to 15 ft from the ground. The nest is built between spines and needles of the host. This is possibly to **deter** possible intruders whereas giving the nest a better grip too.

Workers may travel over 100 feet from the nest in search of food. Acrobat ants feed on a variety of foods including sweets and other insects. They have frequently been observed feeding on termites.

Acrobat ants are extremely **territorial** and only one colony exists in each tree, although a large colony may spread to up to three pine trees if trees are in close proximity to each other. Workers are general scavengers and predators, foraging the length of the 30 to 40 m trees for living and dead insects.

The nests are usually located close to a **honeydew** source. Crematogasters tend **scale** insects under loosened bark of trees in form of small 'tents' or shelters with small entrance holes. Scale insects are also observed on the twig surface. Worker ants visit these scales regularly and feed (in groups of 10-12 individuals) on viscous honeydew like substance excreted by the scales. Ants protect the scales and extract the sweet substance in return. Occasionally some ants **carry** the scales to their nest or even to new locations.

Crematogaster nests are shaped like an egg which is implanted on the branches at a fork or flattened against the tree trunk. The average **oblong** nest may have a diameter of 130mm and a height of 175mm. Decaying organic matter along with wood powder is used for nest construction. This material may be impregnated with **honeydew** and infiltrated by the **fungus** Cladosporium. Gland secretions act as the **binding material** which provides exceptionally strong bonding. The nest consists of innumerable flakes or **cartons**. These may be 5 mm across.

The nest construction starts with a single flake which may also be the bark of the tree itself. The nest slowly grows by addition of flakes over and around the original. The nests do not break or flake easily. The flakes **do not dissolve** even when **immersed** in water (fresh or salty) for 24 hrs ! The nest has many entrances/exits covered by flakes above which are attached to the top of the entrance flake. Thus these act as weather shields and create 'porches'. Each flake also slopes outwards thus providing for water runoff.

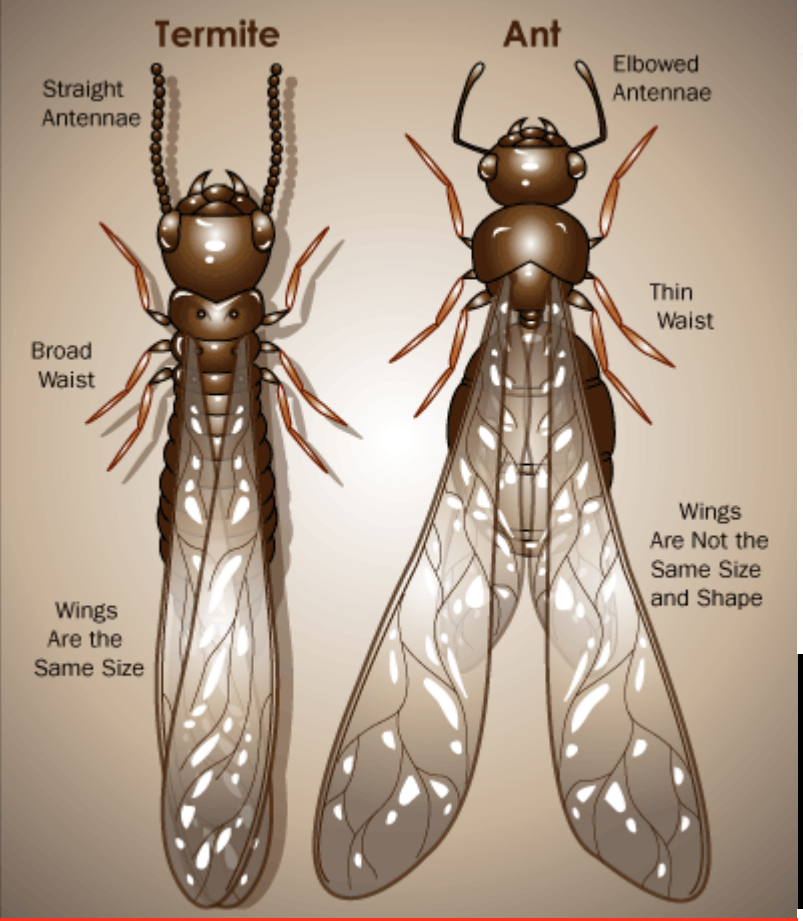
The nest interior consists of **interconnected cells** of different sizes. The cells are usually of diameters varying between 0.5cm to 1.5cm. Cartons are used to divide or **partition** an existing cavity to make smaller passageways.

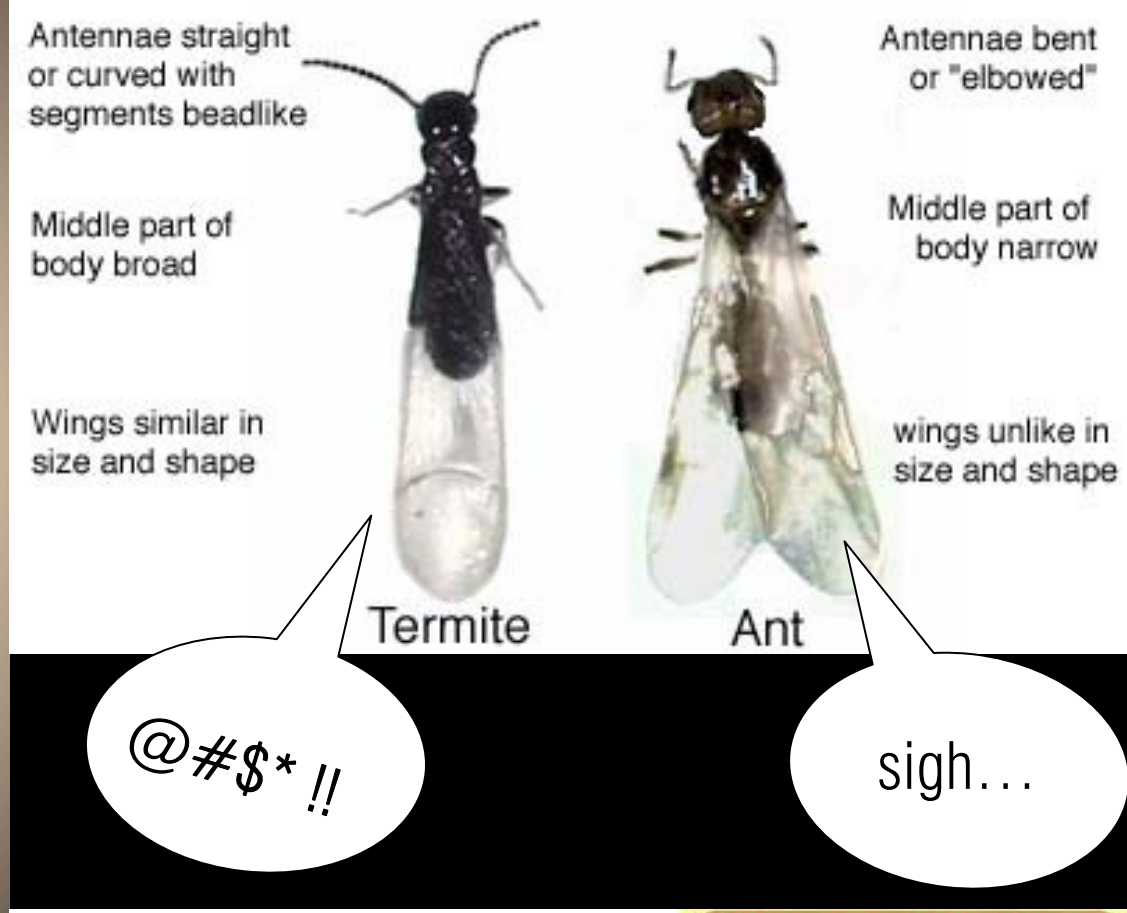
Biochemical Analysis:

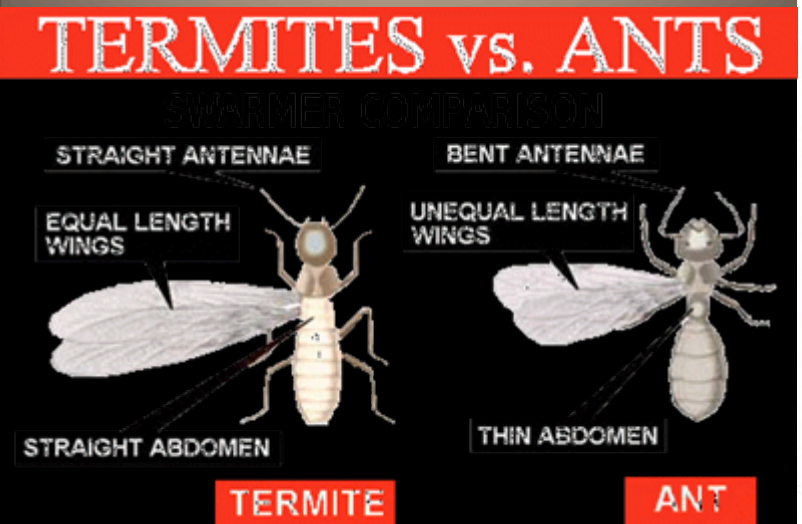
Cellulose content: 100mg/gm wt of nest carton
Proteins: 170mg/gm wt of nest carton
Carbohydrates: 400mg/gm wt of nest carton
Pectic substances: 65%

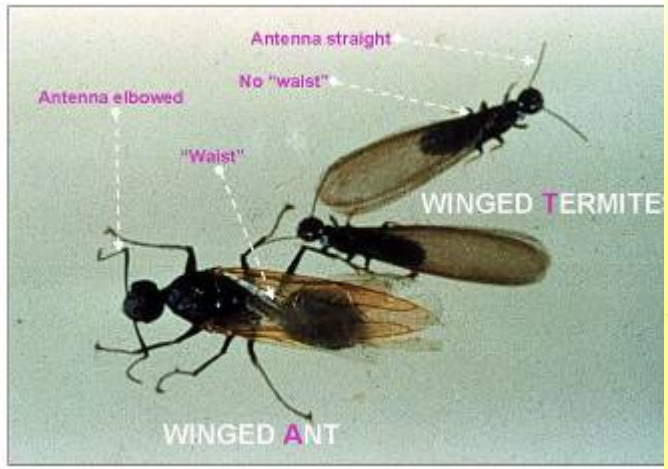
** The cellulose content depends on surrounding plant diversity and shall vary accordingly*

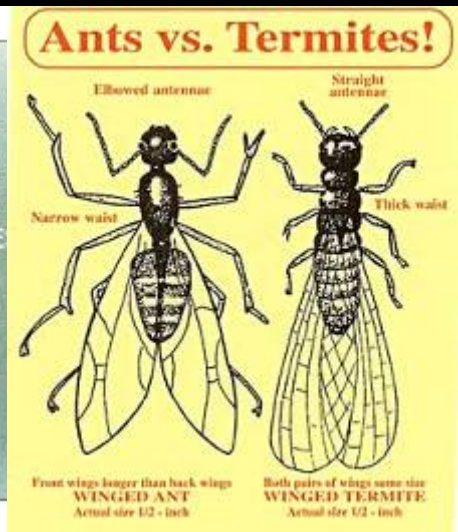
Termites

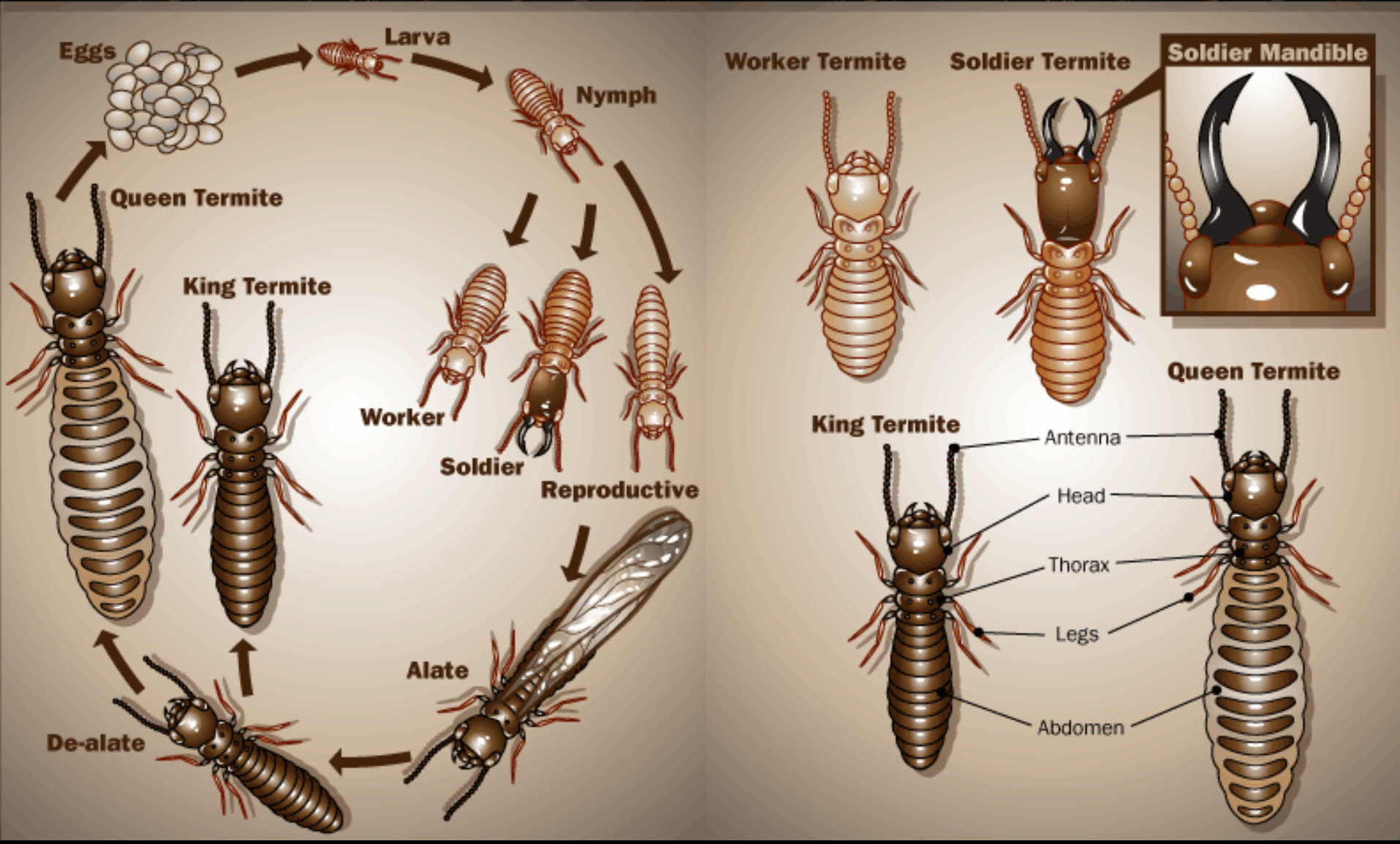

Termite
Ant
Straight Antennae
Elbowed Antennae
Thin Waist
Broad Waist
Wings Are Not the Same Size and Shape
Wings Are the Same Size


Antennae straight or curved with segments beadlike
Antennae bent or "elbowed"
Middle part of body broad
Middle part of body narrow
Wings similar in size and shape
wings unlike in size and shape
Termite
Ant
@#$* !!
sigh…

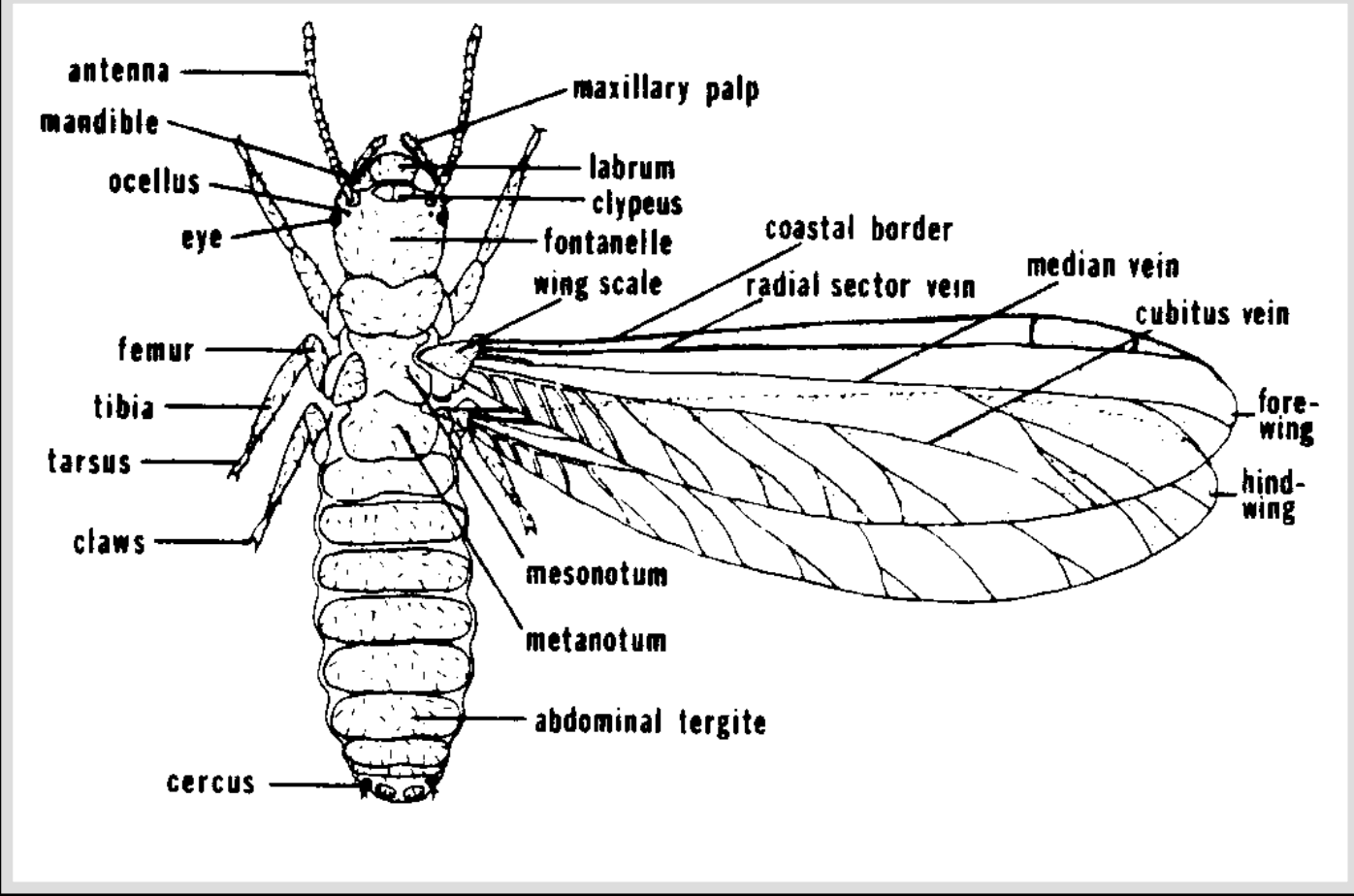

TERMITES vs. ANTS
SWARMER COMPARISON
STRAIGHT ANTENNAE
BENT ANTENNAE
EQUAL LENGTH WINGS
UNEQUAL LENGTH WINGS
STRAIGHT ABDOMEN
THIN ABDOMEN
TERMITE
ANT


Antenna straight
No "waist"
Antenna elbowed
"Waist"
WINGED TERMITE
WINGED ANT


Ants vs. Termites!
Elbowed antennae
Straight antennae
Narrow waist
Thick waist
Front wings longer than back wings
WINGED ANT
Actual size 1/2 - inch
Both pairs of wings same size
WINGED TERMITE
Actual size 1/2 - inch

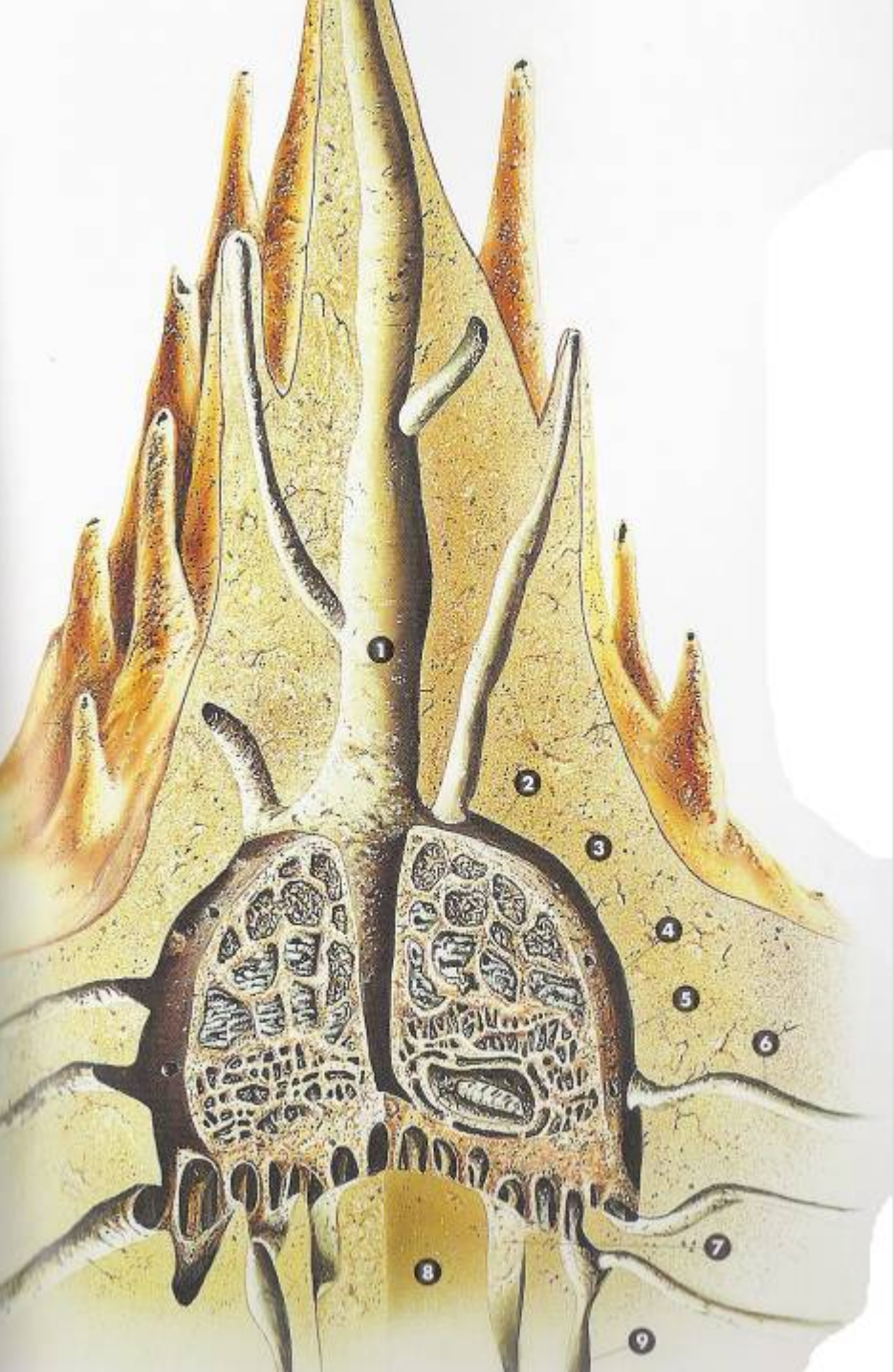


Termite Fundamentals…



Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Subclass:	Pterygota
Infraclass:	Neoptera
Superorder:	Dictyoptera
Order:	Isoptera Brullé, 1832

Termites are able to create elaborate nests and tunnel systems using a combination of soil, chewed wood /cellulose, saliva and faeces. Some species have been known to create such durable walls that industrial machinery has been damaged in an attempt to break their tall mounds. Some African and Australian species have mounds more than 4 metres high. The nest is created and maintained by workers with many distinct features such as housing the brood, water collection through condensation, reproductive chambers, and tunnel networks that effectively provide air conditioning. A few species even practice agriculture, collecting plant matter to feed fungal gardens, upon which the colony then feeds.



Termite hill interior –

1.Ventilation shaft

2.Store of saw dust for making stacks for fungus cultivation

3.Stacks for growing fungus

4.Chamber for raising larvae

5.Royal chamber

6.Horizontal passage leading to the outside

7.Cellar under the papery floor

8.Large central pillar supporting the termite mound

9.Passage leading deep underground

Soil (mud) Sampling:

Sites:

-Pachgaon Parvati

-Vetal Tekdi

-Wagholi

-Tamhini

-Amboli

Results:

Erratic…

Lagniappe..

Schmidt Sting Pain Index*

1.0 Sweat Bee: Light, ephemeral, almost fruity. A tiny spark has singed a single hair on your arm.
1.2 Fire Ant: Sharp, sudden, mildly alarming. Like walking across a shag carpet & reaching for the light switch.
1.8 Bullhorn Acacia Ant: A rare, piercing, elevated sort of pain. Someone has fired a staple into your cheek.
2.0 Bald-faced Hornet: Rich, hearty, slightly crunchy. Similar to getting your hand mashed in a revolving door.
2.0 Yellowjacket: Hot and smoky, almost irreverent. Imagine W.C.Fields extinguishing a cigar on your tongue.
2.x Honey Bee and Euroean Hornet: Like a match head that flips off and burns on your skin.
3.0 Red Harvester Ant: Bold and unrelenting. Somebody is using a drill to excavate your ingrown toenail.
3.0 Paper Wasp: Caustic & burning. Distinctly bitter aftertaste. Like spilling a beaker of Hydrochloric acid on a paper cut.
4.0 Tarantula Hawk: Blinding, fierce, shockingly electric. A running hair drier has been dropped into your bubble bath.
4.0+ Bullet Ant: Pure, intense, brilliant pain. Like fire-walking over flaming charcoal with a 3-inch rusty nail in your heel.

** Subsequently, Schmidt has refined his scale, culminating in a paper published in 1990 which classifies the stings of 78 species and 41 genera of Hymenoptera.*

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