INSECTS · EVOLUTION & GENETICS

Eusocial Insects & Haplodiploidy

What makes an insect society, why termites built one without the genetics of ants and bees, and the 75% sister puzzle.

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> Eusocial insects have the highest level of social organisation in the animal world. Ants, bees, wasps and termites all get there — but termites took a completely different evolutionary road, and that tells us a lot about how insect societies really arise.

01 What does “eusocial” mean?

Eusociality is defined by three main features:

1

Cooperative brood care

Colony members help care for the young — including offspring that aren’t their own.

2

Reproductive division of labour

A small number of individuals reproduce, while others forage, maintain the nest and defend it.

3

Overlapping generations

Parents and offspring live together, so older individuals help raise younger generations.

02 Termites: a eusocial system

Termites are eusocial insects, but they are **not ants**. Modern termites belong to **Blattodea**, the same broader insect order that includes cockroaches. Their closest living relatives include wood-feeding cockroaches such as *Cryptocercus*.

COLONY ORGANISATION

PRIMARY REPRODUCTIVES

King & queen

The main reproductive pair in many termite colonies.

THE WORKFORCE

Workers

Gather food, care for the young, build and maintain the nest, and carry out other colony tasks.

DEFENCE

Soldiers

Specialised defenders with modified jaws or, in some species, chemical defence systems.

BACK-UP BREEDERS

Secondary reproductives

In many species, extra reproductives can develop if the primary queen or king is lost, or if reproduction needs to expand.

COMMUNICATION AND COORDINATION

Termites coordinate colony life using several kinds of signal:

- **Pheromones and other chemical cues**, including signals involved in reproduction and colony organisation.
- **Touch** — tactile communication through contact between individuals.
- **Vibrations and substrate-borne signals**, which can warn of danger or coordinate activity.
- **Trophallaxis** — exchanging food and fluids, which also spreads nutrients, gut microorganisms and chemical information through the colony.

03 Why did termites become eusocial?

Termite eusociality evolved **independently** from that of ants, bees and wasps, and their biology gives strong ecological reasons for living in groups. Many termites feed on cellulose-rich material such as wood, which is hard to digest without microbial partners — and young termites acquire those vital gut microorganisms through social contact with older colony members.

Group living also brings shared nest building, defence, food processing and care of the young. These advantages can make cooperative colonies successful even though termites don't have the haplodiploid genetic system found in many Hymenoptera.

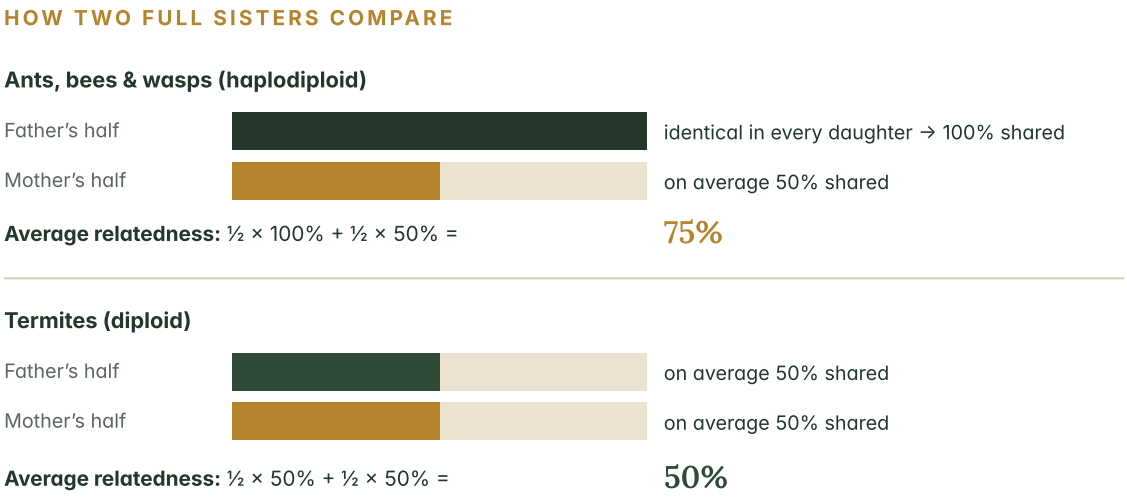
04 Haplodiploidy

Haplodiploidy is a system of sex determination found in many ants, bees and wasps (**Hymenoptera**). Females are usually **diploid** — two sets of chromosomes, developing from fertilised eggs. Males are usually **haploid** — one set of chromosomes, developing from unfertilised eggs.

SYSTEM	FEMALE	MALE
Haplodiploid (many Hymenoptera)	Diploid; fertilised egg	Haploid; unfertilised egg
Termites	Diploid; fertilised egg	Diploid; fertilised egg

05 Why can full sisters share about 75% of their genes?

In a simplified haplodiploid system, a male has just one chromosome set, so **every daughter receives exactly the same set from her father**. Each daughter also receives about half of her mother's chromosomes. On average, two full sisters therefore share:



Simplified model. Because a haploid father passes his whole single set to every daughter, sisters are unusually closely related.

This unusually high relatedness was an important part of early **kin-selection** explanations of eusociality. But haplodiploidy is **not a complete explanation** on its own: most haplodiploid insects are not eusocial, and eusociality has evolved in diploid animals such as termites.

06 Termites vs. ants, bees and wasps

FEATURE	TERMITES	MANY ANTS, BEES & WASPS
Broad classification	Blattodea	Hymenoptera
Sex determination	Diploid	Haplodiploid in many species
Males	Diploid	Haploid
Females	Diploid	Diploid
Primary reproductives	King and queen	Usually a queen; males commonly have a mainly mating role
Workers	Can be male or female, depending on species and caste	Usually female
Siblings' average relatedness	About 50% for full siblings	Full sisters can average about 75% under the simple haplodiploid model
Eusocial?	Yes	Yes, in some lineages

07 The key idea to remember

DON'T MIX THEM UP

Haplodiploidy is a *genetic* system; eusociality is a *social* system.

They are linked in the evolutionary story of ants, bees and wasps, but they are not the same thing. Termites show that eusociality can evolve in a fully diploid lineage. Their society is held together by kinship, the ecological benefits of cooperation, parental care, dependence on gut microbes and strong colony-level coordination.

ON THE DRIVE — HOW TO SAY IT

"People often lump termites in with ants — 'white ants' — but they're actually closer to cockroaches. Ants and bees have an odd genetic system where sisters share about three-quarters of their genes, and that was long used to explain why workers give up breeding to help the queen. Termites don't have that system at all, yet they built societies just as complex. Their reason is in their gut: they need microbes to digest wood, and the young can only get those microbes from the colony."

Quick revision

- **Eusociality** = cooperative brood care + reproductive division of labour + overlapping generations.
- Termites are eusocial but **diploid**, unlike the haplodiploid system of many ants, bees and wasps.
- Termite colonies commonly contain reproductives, workers and soldiers.
- **Haploid** = one chromosome set; **diploid** = two chromosome sets.
- In the simple haplodiploid model, full sisters average about **75%** relatedness.
- Full termite siblings generally average about **50%** relatedness.

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