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BIODIVERSITY
Published: 04 November 2025
doi: 10.3389/frym.2025.1632173

THE WONDERFUL WORLD OF WASPS

Seirian Sumner * ***and Idris Adams*** *

Centre for Biodiversity and Environment Research, Department of Genetics, Evolution, and Environment, University College London, London, United Kingdom

YOUNG REVIEWERS:

KAI
AGE: 9

MIA
AGE: 9

When you hear the word "wasp", you probably imagine a stripey yellow-and-black insect that you see flying about at your summer picnic. You would be right! But there is much more to wasps than you think, and they are not out to get you. There are probably more types of wasp than any other type of insect on the planet, and they all go about their lives in different, fascinating ways. Most wasps do not even have stingers, and live alone rather than in a large group. We will take you on a tour through the diversity of behaviors and life histories that wasps show, why scientists are interested in them, and why you should care about wasps, too.

THE DIVERSITY OF WASPS

Apart from your ice cream melting in the heat, what is the next most annoying thing that happens to you at the height of summer? Perhaps it is the arrival of a wasp at your picnic? Everyone

(especially grown-ups) starts flapping and shouting; sometimes someone gets stung.

Although these bothersome yellow-and-black stripey insects and their big football-like papery nests are what most people think of as a "wasp", there is a lot more to wasps than this. There are over 100,000 species of wasps described; but because so many of them are very small and very under-studied, scientists estimate that there are at least 5–10 times more wasp species to discover. This means wasps are likely to be the most species-rich insects on the planet. The diversity in lifestyles they have evolved is mind blowing [1]!

Let us take a tour through the world of wasps.

SUPERORGANISMAL WASPS

We will start with that pesky picnic-bothering wasp, the yellow jacket—*Vespula vulgaris* is its scientific name (Figure 1). Despite their bad reputation, these insects are not out to get you: they are just looking for food. Just like a honeybee, these insects live in a colony composed of hundreds to thousands of individuals. All but one (the queen) are worker wasps, who spend their time foraging for food to feed to the hungry wasp larvae—who happen to be their siblings. These insect societies are **superorganisms**, which means they are actually a lot like you, because your body is also a superorganism! The workers and queen are inseparable: they cannot function without each other—just like your body organs cannot function without each other. Workers are like the non-reproductive organs in your body—your heart, lungs, and liver: they all perform specialized tasks but will never reproduce.

SUPERORGANISM

A large group of individuals that have specialized roles in their societies. Individuals in superorganismal societies work together, like the organs in your own body, and cannot function alone.

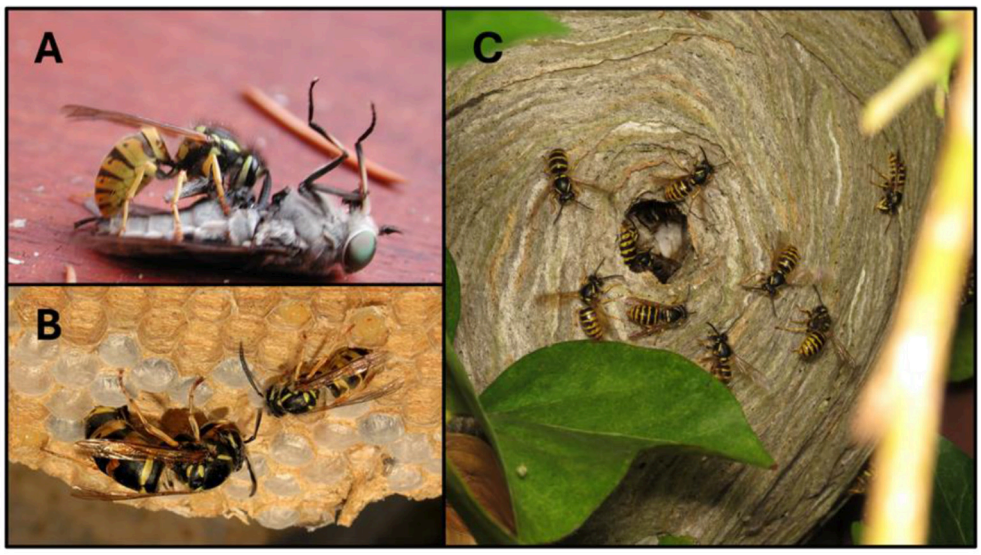

Figure 1

Social wasps. **(A)** A yellow jacket, *Vespula germanica*, with a horse fly. Yellow jackets are generalist predators, meaning they will eat many different types of food. **(B)** Two yellow jackets inside their nest. On the left is the large queen, the only reproductive female in the colony. The smaller wasp is one of her workers—non-reproductive helpers. **(C)** The entrance of a yellow jacket nest. Wasp nests such as these usually have only one entrance, making it easy to defend from intruders [Image credits **(A)** Wikimedia Creative Commons Robert Goossens_CC-BY-SA 3.0; **(B)** Cintia Akemi Oi; **(C)** Wikimedia Creative Commons Donald Hobern_CC-BY-SA 2.0].

Worker wasps do all the brood care: this includes hunting a huge diversity of prey. Yellow jacket wasps are known to hunt everything from flies, to spiders, to caterpillars; they also take chunks of meat from dead animals—that is why they like your BBQ sausages or your ham sandwich. The prey is fed to the hungry larvae back in the nest.

The queen is like your reproductive organs: she is the only individual in the colony who will reproduce. She is only an active queen for about 6 months but in that time, she will lay up to 10,000 eggs. Most of these become her workers; but a small number of them become the sexual offspring—males and new queens. This all takes place inside a big papery nest, which they make from dead wood, like logs, wooden fences, or garden furniture.

GERONTOCRACY

A society ruled by the oldest individual. In some wasp societies, the oldest female is the queen; when she dies, she will be replaced by her oldest daughter. Pronounced jer-on-toh-crah-see.

A SIMPLE SOCIAL LIFE

Not all wasps live in such big societies. Some live in very small societies with as few as 5–20 individuals; the hover wasps—a group of wasps with the scientific name Stenogastrinae—of Southeast Asia are a good example. As the name suggests, they look a bit like hover flies due to their distinctive hovering flight. The nest consists of a handful of females, one of which is the queen. The other wasps are her daughter workers: they help rear the younger offspring (their siblings) by foraging for prey and tending the brood. If the queen dies, her oldest daughter worker replaces her: these wasps form an orderly queue according to their age to decide who will be the next queen. This type of society is called a **gerontocracy**.

Hover wasps' nests are incredibly diverse. Some build paper nests that are easily mistaken for tree roots. Others build mud nests that look like up-side-down cupcakes. You can identify the type of wasp based on what its nest looks like (Figure 2).

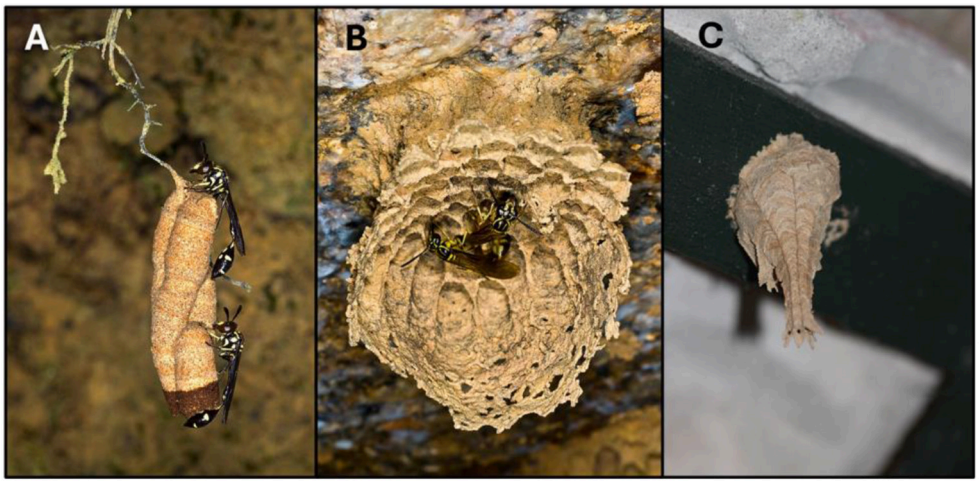

Figure 2

Figure 2

Diversity of hover wasp nests. **(A)** The nest of *Parischnogaster striatula*. Their nests look like roots and are built using mud collected by the female wasps. **(B)** The "upside-down cupcake" nest of *Liostenogaster flavolineata*. Like other hover wasps, the oldest female on this nest will be the egg-layer until she dies. **(C)** The nest of a *Eustenogaster* hover wasp species. Like all hover wasps, the entrance faces the ground to deflect raindrops [Image credits: **(A)** Wikimedia Creative Commons David Baracchi_CC-BY-SA 4.0; **(B)** Wikimedia Creative Commons David Baracchi_CC-BY-SA 4.0; **(C)** Seirian Sumner].

WASPS THAT LIVE ALONE

People notice social wasps because there are usually a lot of them in one place. However, 99% of wasp species are solitary. This means they live alone, not in a colony. There are over 30,000 described species of stinging wasps that live like this, and they come in many different sizes and colors. Despite their lonely lives, a female solitary wasp can rear hundreds of offspring over the course of her life. She will dig a burrow or construct a mud nest and hunt prey for each offspring. The prey is usually another insect (like a caterpillar, beetle, bug, or fly) or another type of arthropod like a spider. She will use her sting to paralyze the prey, which she carries back to her nest; she lays an egg on the paralyzed prey and seals up the entrance. For most solitary wasps, that is the last the mum will ever see of her baby. This might not sound like great parenting, but the paralyzed prey provides all the nourishment needed for the baby wasp to develop into an adult wasp. The prey is a motionless, living larder—the wasp larva eats it alive!

We know surprisingly little about the fascinating, secret lives of solitary wasps as they are very under-studied relative to the more social wasps. But the few that we do know about are pretty incredible. Let us take a look at a few.

The beewolf—*Philanthus triangulum*—is a solitary wasp common in temperate parts of the world (Figure 3B). It has a **symbiotic relationship** with the bacteria *Streptomyces*, which produces antibiotics and helps the wasp to fight off fungal infections [2]. Just as you might take antibiotics to tackle an infection, the female wasp packs some of these bacteria into the nest when she lays an egg; the bacteria produce the antibiotic streptomycin, which helps to protect its larva from infection.

SYMBIOTIC RELATIONSHIP

An interaction between two different species. Symbiotic relationships can be good for both species involved, such as between the beewolf and *Streptomyces* bacteria.

Another amazing solitary wasp is the cockroach-hunting jewel wasp *Ampulex compressa* (Figure 3C). The wasp larva secretes an antimicrobial mixture of compounds to protect itself from disease [3]. The adult jewel wasp also possesses a unique cocktail of chemicals that it injects directly into the nervous system of its cockroach host, causing the zombified prey to slow down and become much easier to lead back to its tomb, to be fed on by a baby wasp.

The beewolf and the jewel wasp are examples of hands-off parenting. But some solitary wasps do put a bit more effort in. The digger wasp *Ammophila pubescens* (Figure 3A), for example, will visit her growing larvae several times through their lives, adding extra food when needed. Each wasp looks after up to nine nests at any one time: this means she can remember not only the locations of multiple burrows but also how much food she has fed each one and *when* the larvae need feeding again [4]. Most humans would struggle to achieve this—and it is all done by a tiny brain!

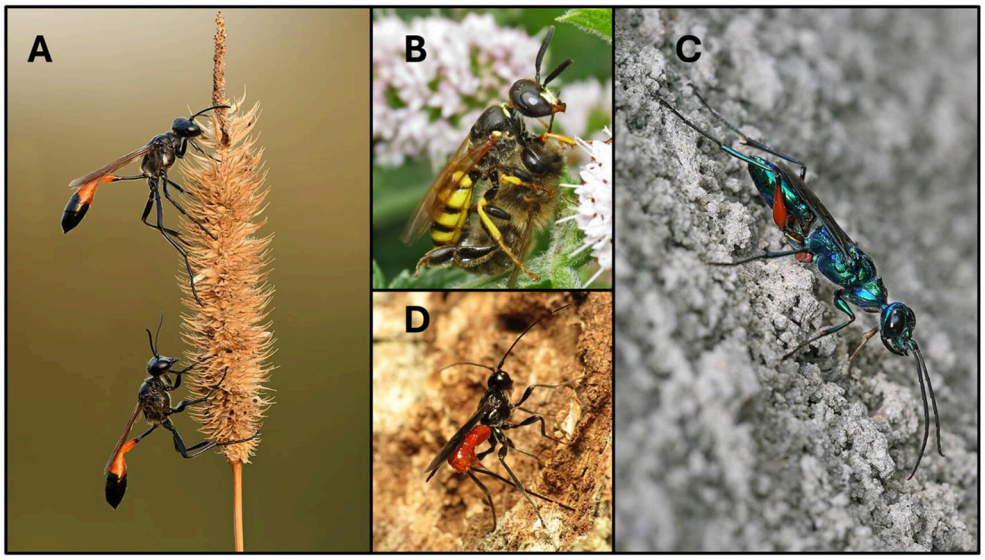

Figure 3

Figure 3

Solitary wasps. **(A)** Two individuals of the stinging solitary wasp, *Ammophila pubescens*. These wasps can remember the locations of up to nine nests at a time! **(B)** The beewolf, *Philanthus triangulum*. Beewolves use their symbiotic relationship with bacteria to protect their young. **(C)** The jewel wasp, *Ampulex compressa*, uses a cocktail of chemicals to capture its prey and lead it back to its nest. **(D)** A braconid parasitoid wasp using its ovipositor to lay eggs under the bark of a tree. These wasps do not have a stinger and only use their ovipositor for egg-laying [Image credits: **(A)** Wikimedia Creative Commons Ivar Leidus_CC-BY-SA 4.0; **(B)** Wikimedia Creative Commons Martin Cooper_CC-BY-SA 2.0; **(C)** Wikimedia Creative Commons Muhammad Mahdi Karim_GFDL-1.2; **(D)** Wikimedia Creative Commons Katja Schulz_CC-BY-SA 2.0].

PARASITOID

An insect whose larvae develop on or inside another organism, eventually killing it. Many parasitoid wasps are used in biocontrol. Pronounced par-uh-sit-oid.

OVIPOSITOR

The egg-laying organ in wasps and other insects. Some wasps have adapted their ovipositors to become stingers, used for defense.

The solitary wasps might be a little bit gruesome, but they are really important in understanding social wasps. This is because all social wasps evolved from wasps that were solitary. How their behaviors became adapted and modified to produce the diversity of social lives that wasps have is a big question that scientists are still trying to answer.

WASPS WITHOUT STINGS

Perhaps the most surprising thing about wasps is that most of them do not have stings. The non-stinging wasps are known as the **parasitoids** (Figure 3D), and they represent over 70,000 described wasp species [5]. Instead of a sting, they have an egg-laying sheath, called an **ovipositor**, which they use to lay eggs into hosts. The ovipositor is often very long compared to the rest of the body, in some cases up to eight times the length. This, combined with their skinny "wasp waist", allows parasitoid wasps to bend their bodies to reach host prey in hard-to-reach places. This means many parasitoids have evolved to lay their eggs on host prey hidden within leaves and even under tree bark.

Unlike social and solitary wasps, parasitoids do not construct nests of their own; instead, they have evolved a huge range of strategies to protect their eggs. Gall wasps manipulate plants to grow protective tissue around the wasp egg, called galls, that provide the wasp larva with protection and nutrition. Others, known as **endoparasitoids**, lay their eggs inside the bodies of insect hosts; the wasp larva then eats the prey from the inside out. Scary stuff, even if they do not have a sting! In fact, the ovipositor of the parasitoids evolved before the stinger—all the stinging wasps evolved from these non-stinging

ancestors, and have adapted their ovipositors to be used for defense and prey capture.

ENDOPARASITOID

A parasitoid (see definition above) that lays its eggs inside the body of another organism, eventually killing it. After hatching, the larvae will eat the host from the inside-out.

WHY WASPS MATTER

The extreme diversity of wasps can be used by scientists to answer many important questions. What are the roles of wasps in the environment, as pest controllers or as pollinators? Comparing the diets of different wasps and seeing which flowers they visit can help us understand this. How and why do those huge superorganismal societies evolve? What roles do different individuals have in these societies and what can they teach us about our own societies? How can wasps help humans? Many parasitoids are released on farms and used as **biocontrol**, to help control insect agricultural pests, and in many countries (especially in Asia, South America, and Africa) wasp larvae are eaten by humans because they are really nutritious. These are just a few examples of the reasons we can, and should, be fascinated by the world of wasps; remember this the next time you see a yellow jacket wasp at your picnic!

BIOCONTROL

Using living organisms, like animals or fungi, to manage farmland pests. Some wasp species are used in biological control because they lay their eggs on pest species.

ACKNOWLEDGMENTS

IA was funded by a PhD studentship from the UK's Natural Environment Research Council (NERC). SS was supported by grant funding from NERC (NE/Y001397/1).

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SUBMITTED: 20 May 2025; **ACCEPTED:** 20 October 2025;
PUBLISHED ONLINE: 04 November 2025.

EDITOR: Didone Frigerio, University of Vienna, Austria

SCIENCE MENTORS: Rebecca Trueman and Andrew Katsis

CITATION: Sumner S and Adams I (2025) The wonderful world of wasps. Front. Young Minds 13:1632173. doi: 10.3389/frym.2025.1632173

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YOUNG REVIEWERS

KAI, AGE: 9
Kai is a 9-year-old adventurer from Canada who explores the wonders of nature through extreme sports like skiing deep powder and wakeboarding. His love for science and biodiversity has taken him on wild journeys—he has saved a shark, released baby turtles, and snorkeled in both the Atlantic and Pacific Oceans. Whether he is chasing adrenaline or spotting wildlife, Kai is always learning from the natural world he loves so much.

MIA, AGE: 9
Hi, my name is Mia. I enjoy insects, drawing, and learning about science. When I am older, I want to be an entomologist, and my favorite insect is the spiny flower mantis (*Pseudocreobotra wahlbergi*). I love to spend time in the garden hunting for creepy-crawlies—if I can find them—but I try not to get my hands too dirty.

AUTHORS

SEIRIAN SUMNER

Seirian Sumner is a British professor of behavioural ecology at University College London. She studies social insects but is especially fond of wasps. Alongside her science on social evolution, genomics and behaviour, she is co-founder of the citizen science project, Big Wasp Survey; and author of the popular science book *Endless Forms: Why You Should Love Wasps*. She was recently nominated to the Explorer's Club EC50 Class of 2024 as one of 50 people changing the world, who the world needs to know about. *s.sumner@ucl.ac.uk

IDRIS ADAMS

Idris is a PhD student at University College London, studying the evolution of prey type and nesting behaviors in wasps. He is particularly interested in the stinging solitary wasps, and the diversity that they show in their life histories. He has previously worked with bees and other insects, and in his spare time likes to read and go for long walks in nature! *idris.adams.23@ucl.ac.uk