ZOO LIFE pollinators

The future is on their wings.

ZOO LIFE POLLINATORS - Zoos as local restoration and conservation hotspots in urban and peri-urban areas and citizen science ambassadors to reverse the decline of pollinators in anthropic spaces

DELIVERABLE – D4.2

Pollinator Ambassador Toolkit

DATE: 6th March 2026

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External Resources

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A simple guide to discovering and protecting pollinators

Pollinating insects are all around us, and they make our world bloom - literally!

Pollinating insects play a fundamental role in our daily lives, even if we don't always notice them. Bees, butterflies, hoverflies, beetles, and many other species help plants reproduce, support biodiversity, support healthy ecosystems and contribute to the food we eat every day. The Pollinators Ambassador Toolkit was created to help you learn more about these extraordinary insects, understand why they need our help and discover how you can make a difference through simple explanations, practical examples and inspiring actions: this toolkit shows how everyone can play a crucial part in protecting pollinators.

Whether you are a visitor, an educator, a zoo professional, or simply curious about nature, this guide invites you to look at your surroundings with new eyes and discover how small changes can make a big difference for pollinating insects and for our planet.

1. The Zoo LIFE Pollinators project

1.1 The project

Pollinating insects are disappearing, especially in cities and the areas around them. One of the main reasons is the loss of suitable habitats: fewer flowers, fewer green spaces, and less spaces for insects to live, feed, and reproduce.

Across Europe, around 9% of wild bee species, 40% of hoverfly species and 15% of butterfly species are declining in both abundance and diversity.

Human activities are the main cause of this loss, especially in urban and peri-urban areas, where habitat loss, intensive agriculture, and climate change are the main drivers of this ongoing crisis.

This project was created to help stop this decline in Europe's urban and peri-urban areas, using a practical and innovative approach. Surprisingly, zoos are proving to be important allies in this effort.

With their large green spaces, trained staff, and strong connections to the public, zoos are uniquely positioned to support pollinators.

16 partners in 9 European countries have joined forces to tackle the decline of wild pollinators.

At the heart of the project, 8 zoos are leading the initiative, becoming real "conservation hubs" for pollinators. They are restoring natural habitats, supporting breeding programs for pollinating insects, and involving visitors in conservation efforts. Instead of focusing only on conservation in controlled environments, the project works directly in the places where pollinators live. The goal is to protect and improve habitats in the city itself, helping local insect populations survive and thrive.

More than 926 hectares of urban and periurban areas will be restored and managed in a way that is friendly to pollinators. These spaces will provide food, shelter, and nesting sites, helping existing populations recover and attract new pollinators to nearby areas. At the same time, the project will develop breeding activities that serve both conservation purposes and as educational examples for the zoo visitors, students and citizens.

Zoos will also play a key role in raising awareness: every year, they welcome millions of visitors and work closely with local authorities and other organizations. Thanks to these strong connections, the project will share practical guidelines, good practices and educational campaigns across Europe, encouraging cities and communities to take action and create a more pollinator-friendly environment.

1.2 The partnership

The project is carried out by a European partnership involving 8 different countries: Denmark, Sweden, Croatia, Italy, Hungary, Romania, UK and Spain (Fuerteventura, Canary Islands). It brings together the zoos of Copenhagen, Gothenburg, Nordens Ark, Zagreb, Zoom Torino, Debrecen, Brașov, and Fuerteventura. The partnership is supported and coordinated through the scientific and technical expertise of Fondazione Zoom, the University of Turin, the University of Zagreb and Smart Revolution.

The map below shows the distribution of partners across Europe.

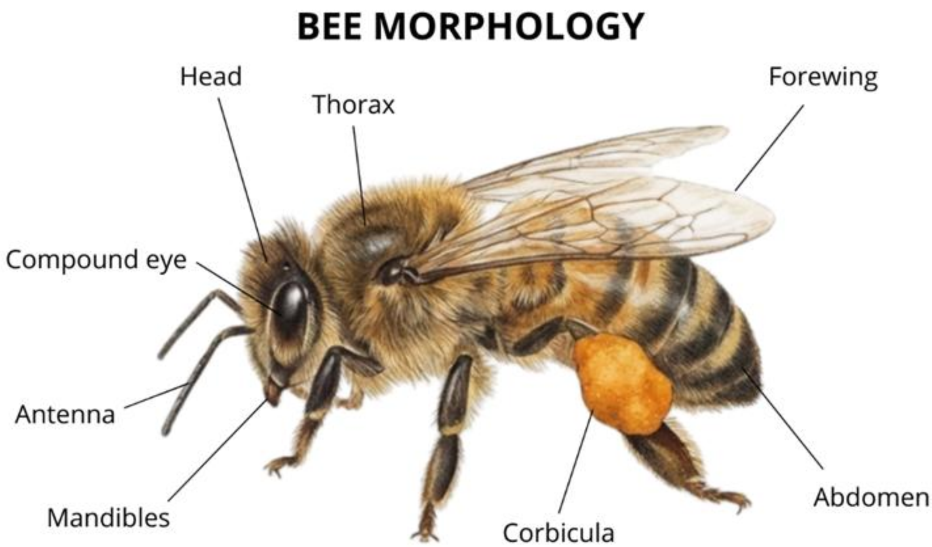
2. Pollinator insects

Insects are the most widespread and successful organisms on Earth, accounting for over 70% of all known animal species. They can be found almost everywhere, and they play essential roles in maintaining ecosystem balance: one of the most important of these roles is pollination. Some insects, as they move from flower to flower in search of nectar and pollen, enable plants to reproduce and help sustain biodiversity, as well as the production of many of the foods we eat every day. But who are these valuable allies of nature? Let's discover pollinating insects.

2.1 Who are you calling an insect?

The animal in front of us can be identified as an insect if it has these key features:

- A body divided into three sections – head, thorax, and abdomen
- Three pairs of jointed legs
- One pair of antennae



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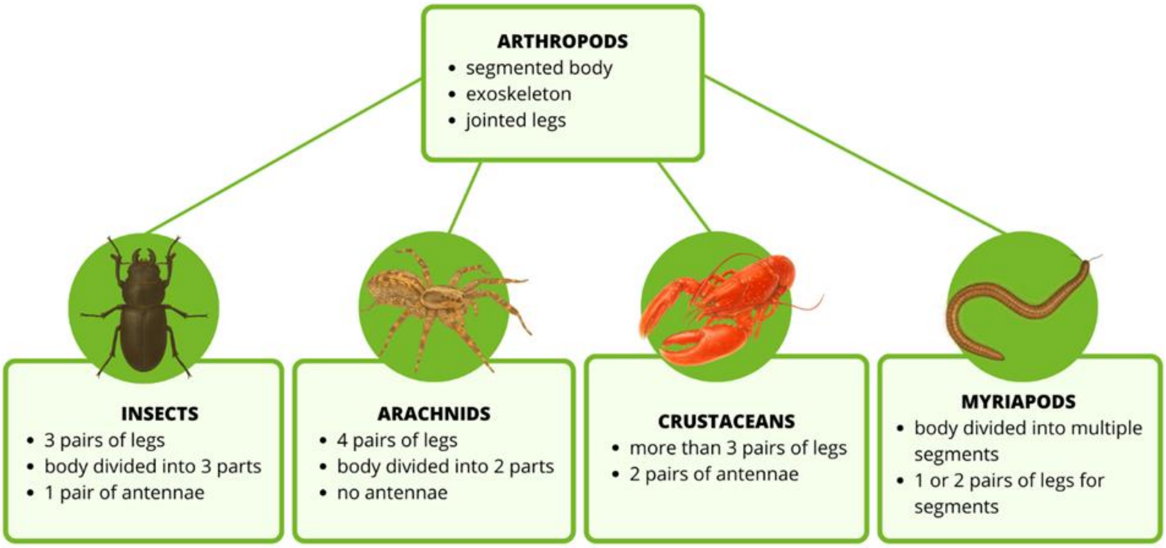
Although these traits make identification straightforward, insects are often confused with other arthropods. In fact, insects, **arachnids, crustaceans, and myriapods** all belong to the large **phylum Arthropoda**, sharing fundamental characteristics:

- A segmented body
- An exoskeleton
- Jointed legs

The main groups of arthropods can be distinguished by a few key characteristics. The table below summarizes the most relevant traits for insects, arachnids, crustaceans, and myriapods.



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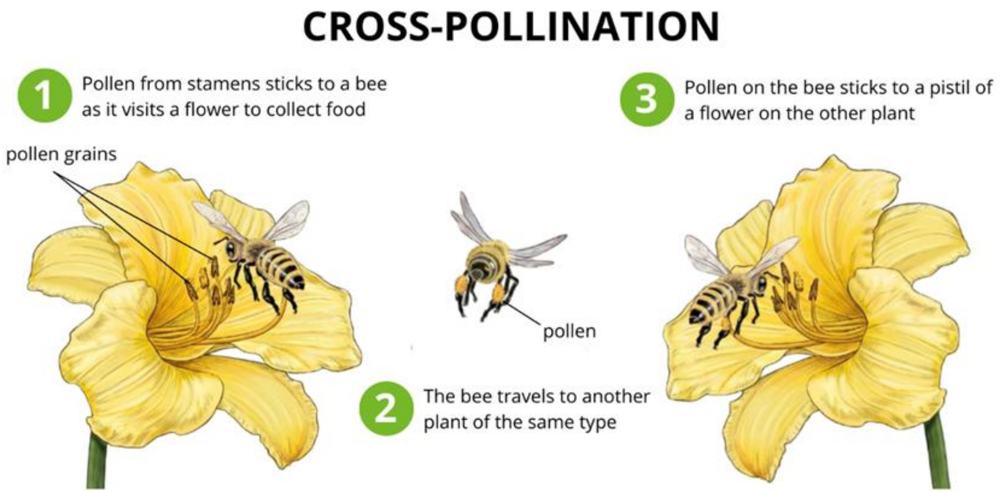
2.2 The Challenge of Pollination

Flowering plants rely on sexual reproduction, which requires exchanging genetic material with another individual of the same species. But unlike animals, plants cannot move. To reproduce successfully, they must find ways to transfer pollen from one flower to another, and over millions of years they have evolved ingenious solutions to a series of biological challenges.



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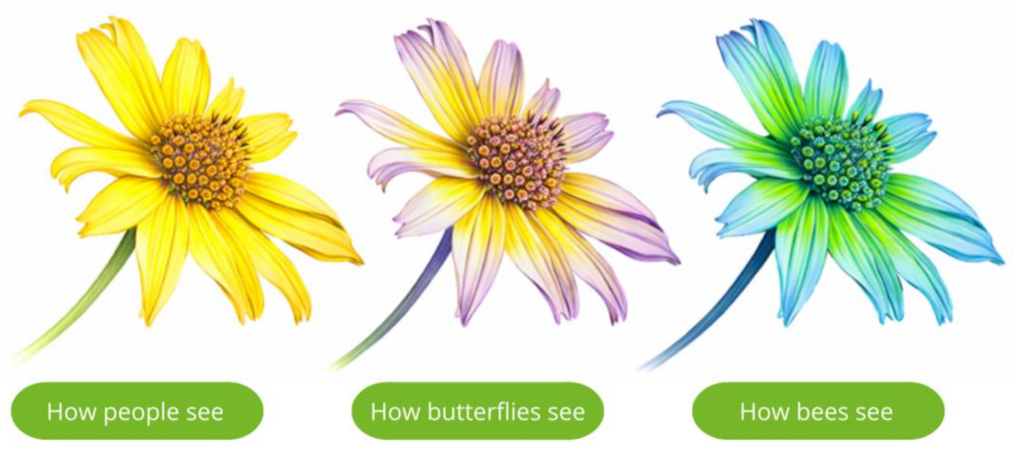
Additional External Resources: An example of insect pollinating can be observed in this publicly available video > https://www.youtube.com/watch?v=DmQ4_9ITqiM

The challenges:

1. **The mobility challenge**
    - The difficulty: plants cannot move to reach a partner or search for mates.
    - The solution: they rely on external vectors (wind, water, or animals) capable of transporting pollen across space.

2. **The attraction challenge**
    - The difficulty**:** animals don't approach flowers by chance, it's the plant's job to make them want to.
    - The solution**:** flowers evolved visual signals (colour, patterns, shapes), chemical cues (scents) and above all an energy-rich reward, nectar.

      UV Secrets: The Invisible Guide to Nectar: the way insects see the colourful world of flowers is different from our perception: human vision is based on the colours red, green, and blue. Many insects can perceive ultraviolet (UV) light, which is invisible to the human eye. Flowers take advantage of this ability by creating UV patterns and signals on their petals, like true "treasure maps" guiding the insect to the nectar. These signals help the pollinator land in the right spot, ensuring contact with the stamens and pistil, and increasing the effectiveness of pollination.



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3. **The reward challenge**
    - The difficulty: For the animal to transport pollen, the plant must ensure that contact with the anthers is inevitable while the insect searches for nectar.

- The solution: Reward is placed at the bottom of the flower to maximise pollen adhesion, from stamen to the insect’s body.

Additional External Resources: An example of insect pollinating can be observed in this publicly available video: Bees in slow motion - shot on iPhone at 240fps

4. **The transport challenge**
   - The difficulty: Finally, the pollen that has been collected must reach the flower of another plant of the same species. It’s necessary to increase the chances that this happens.
   - The solution: Many plants synchronize their flowering; the flowers emit odors, visual and chemical signals that attract only certain species of pollinators, and their shape can also allow only some insects to access the nectar inside. In this way, a kind of fidelity between pollinators and flowers is established.

After overcoming all these challenges, pollination achieves its purpose: the flower transforms into a fruit, inside which the seed will grow into a new plant, thus completing the reproductive cycle.

Additional External Resources: An example of flower-to-fruit development can be observed in this publicly available video: https://www.youtube.com/watch?v=SHHkmOh942A

2.3 The evolutionary dance: understanding the "Perfect match"

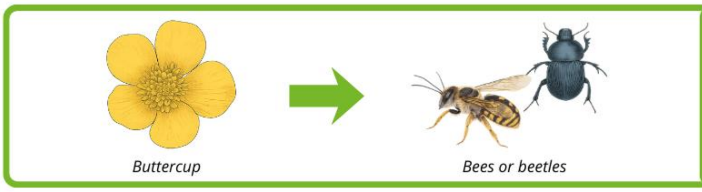
Nature does not rely on random chance. Pollination is often described simply as the transfer of pollen but looking closer reveals a complex system of "locks and keys”. The relationship between a flower and its pollinator is the result of millions of years of refinement - a biological strategy known as co-evolution. Flowering plants and their pollinators are linked by one of the most refined examples of coevolution in the natural world. Over millions of years, the shape, colour, scent, and structure of flowers have evolved in close association with the sensory abilities, body size, mouthparts, and behaviours of the animals that visit them". Flowers have evolved distinct morphologies designed to attract, accommodate, or even manipulate specific insects to maximize reproductive success. In turn, pollinators have adapted physical traits - such as tongue length, body size, and sensory perception - to access the resources these flowers offer. This reciprocal adaptation has generated an extraordinary diversity of forms and interactions, in which each partner influences the evolutionary trajectory of the other.

The relationships illustrated in the infographic below, highlight how floral morphology and pollinator biology often "match" with remarkable precision. Every flower tells a story of survival.

Open corollas and exposed stamens favour generalist insects that can easily access pollen and nectar. Tubular flowers with nectar hidden at the base are selected for visitors with long tongues capable of reaching deep rewards. Closed or narrow corollas require pollinators to enter the flower, ensuring direct contact with reproductive organs. In more specialized systems, flowers may even mimic the appearance or scent of a potential mate, triggering highly specific pollination behaviours.

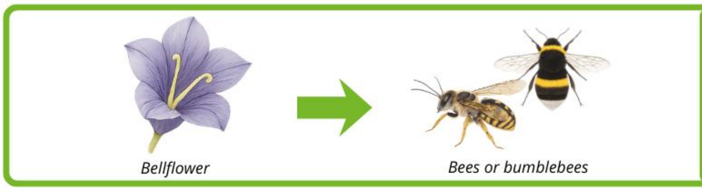
These coevolved matches are not aesthetic curiosities, but the functional basis of plant reproduction and a cornerstone of terrestrial biodiversity. Understanding how flowers and pollinators fit together helps explain why conserving pollinator diversity is essential not only for maintaining ecological processes, but also for preserving the evolutionary heritage embedded in every bloom.

This toolkit invites us to explore these finely tuned partnerships and to communicate how rotecting pollinators means safeguarding the intricate biological dialogue between plants and animals that shapes our landscapes and sustains life on Earth.

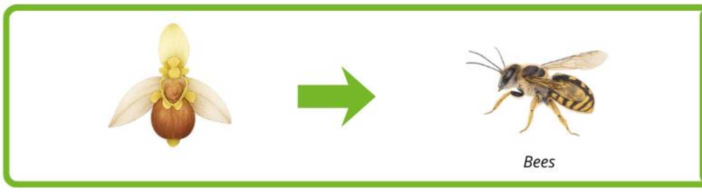


The **buttercup** has open corollas and exposed stamens, accessible to many insects. Any pollinator can easily collect pollen and nectar

Primroses have tubular corollas with nectar at the base: only insects with a long enough tongue can reach it, transporting pollen as they feed



The closed corolla of the **bellflower** requires the insect to enter with its body, increasing contact with stamens and pistil



The **orchid**'s labellum mimics a female bee: the male attempts to mate, and in doing so pollinates the flower

Daisy

Bees or hoverflies

The capitulum inflorescence and the petals forming a small tube of the **daisy** make nectar concentrated and easily accessible to various pollinators

Wild carrot

Butterflies

The wide landing platform and flat flowers of the **wild carrot** id perfect for butterflies to comfortably collect nectar

(images AI generated)

2.4 Meet the pollinators: which animals make it possible?

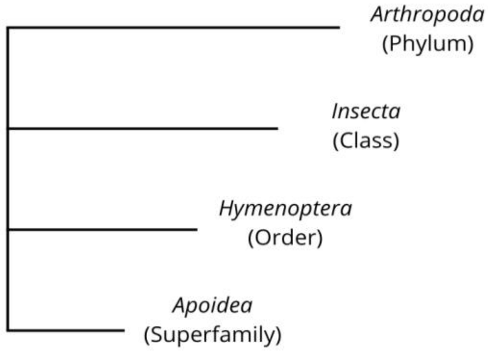
To act as a pollinator, an animal must have some fundamental characteristics:

- Share the same habitat as the plant: in order to visit the flowers, the pollinator must live in the same environment as the plant, at least during its flowering period.
- Be attracted to nectar: the flower offers a reward in the form of food; only animals that seek nectar or pollen as a source of energy are motivated to visit flowers.
- Have a body capable of carrying pollen: bristles, hairs, or feathers allow pollen to stick to the animal and be transferred from one flower to another.

Insects are among the most effective pollinators thanks to traits that make them particularly well-suited for this role:

- Mobility: by flying, they can carry pollen over long distances, connecting distant plants.
- Precision: many insects, thanks to their straw-like mouthparts, can collect nectar and come into contact with stamens and pistils without damaging the flower.
- Dependence on nectar: for some insect species, nectar is their exclusive source of food, ensuring frequent and targeted visits to flowers.

2.4.1 Bees (*Hymenoptera Apoidea*)

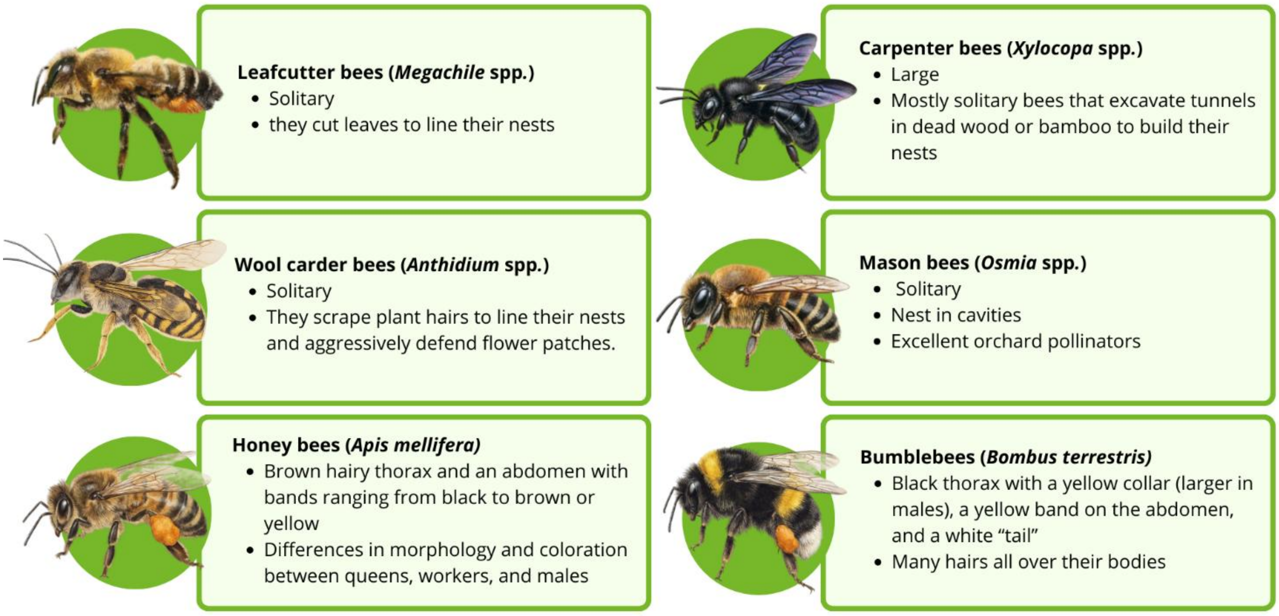


20,000 – 25,000
species worldwide, present on every continent except Antarctica

2,000
species in Europe

General characteristics:

- 2 pairs of membranous wings
- antennae are made up of numerous segments: 12 in females and 13 in males.



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Social insects (honey bees and bumblebees):

- They live in colonies with well-defined roles (queen, workers, drones); building a hive is an evolutionary strategy to protect eggs and food reserves, increasing the chances of offspring survival.

- They can carry large amounts of pollen, placed in pollen baskets, but most of it is collected for the hive and therefore not available for pollination.

- However, they are active for many months throughout the year and are obliged to feed on flowers, making a major contribution to pollination.

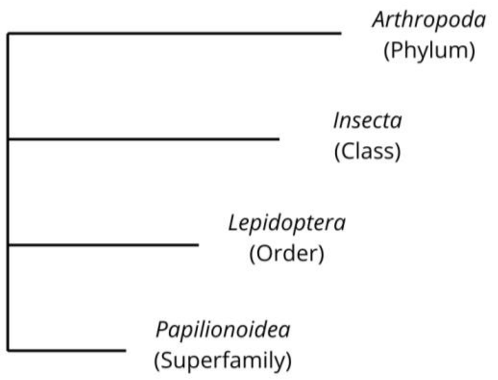
  Type of nest: honey bees and bumblebees live in organized colonies in a hive. This is made of wax and can be built in natural cavities, such as hollow trunks. Inside the hive cells, bees store honey and pollen and the queen lays eggs. Humans have therefore built artificial hives to mimic the places where bees would naturally nest.

Solitary insects (wild bees):

- Each female builds her own nest and collects pollen only for herself or for her eggs.
- They carry smaller amounts of pollen than social insects, but almost all of it is available for pollination, making them more efficient.
- They visit various flowers without the systematic precision of social species but can reach less accessible plants.

  Type of nest: most wild bees dig their nests in the ground, storing provisions and laying their eggs there, or they use pre-existing cavities. Some species, on the other hand, use pre-made cavities such as plant stems or man-made structures, which are often lined with mud, resin, pieces of leaves, etc. Wild bees are very difficult to identify. If you want more information, visit https://pollinatoracademy.eu/factsheets/bee-genera

2.4.2 Butterflies and moths (*Lepidoptera*)

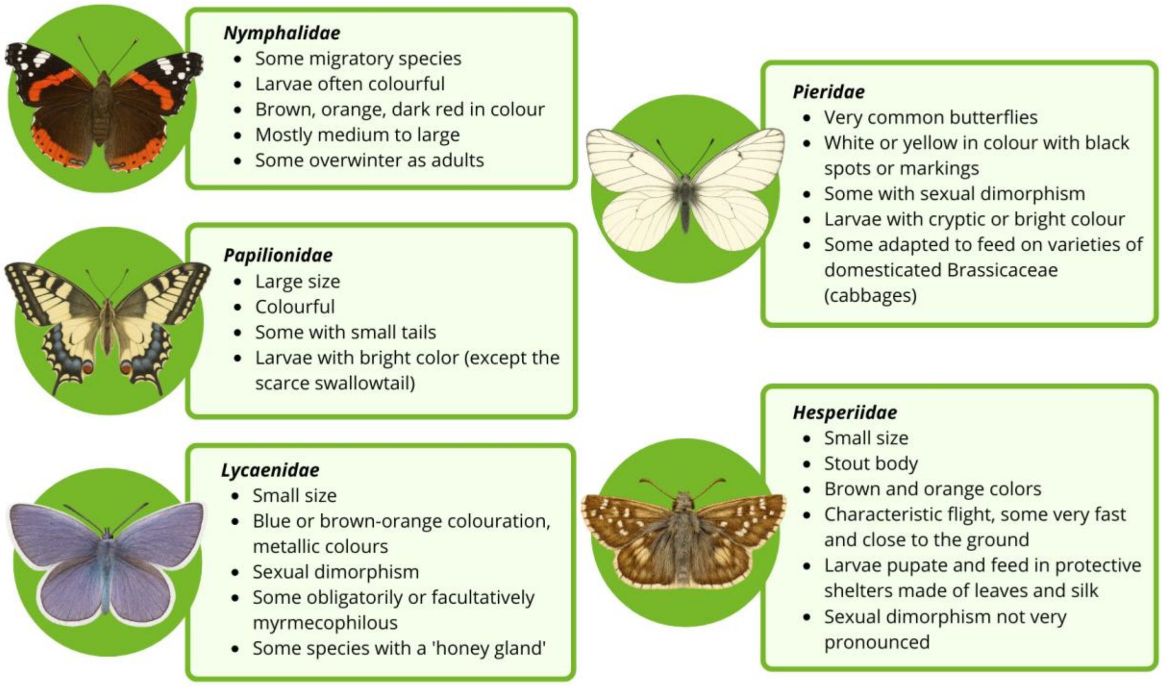


160,000 – 180,000
species worldwide, present on every continent except Antarctica

10,000 - 11,000
species in Europe, divided into:
- butterflies (about 500 species)
- moths (about 9,500 - 10,500 species)

General characteristics:

- Wings covered with tiny scales that create various colours and patterns.
- Mouthparts in the form of a coiled proboscis suitable for sucking nectar.



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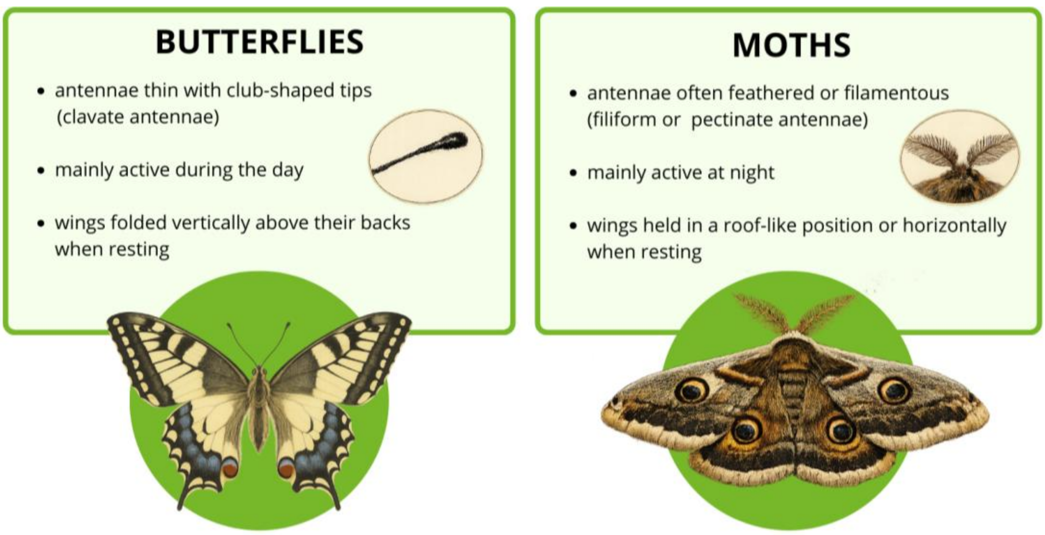
Butterflies or moths? That is the question!

When we look at these two beautiful groups of insects, it is easy to confuse them at first glance. However, butterflies and moths have distinct characteristics that help us tell them apart. Below, you will find the main differences, which make it simple to recognize whether you are observing a butterfly or a moth.



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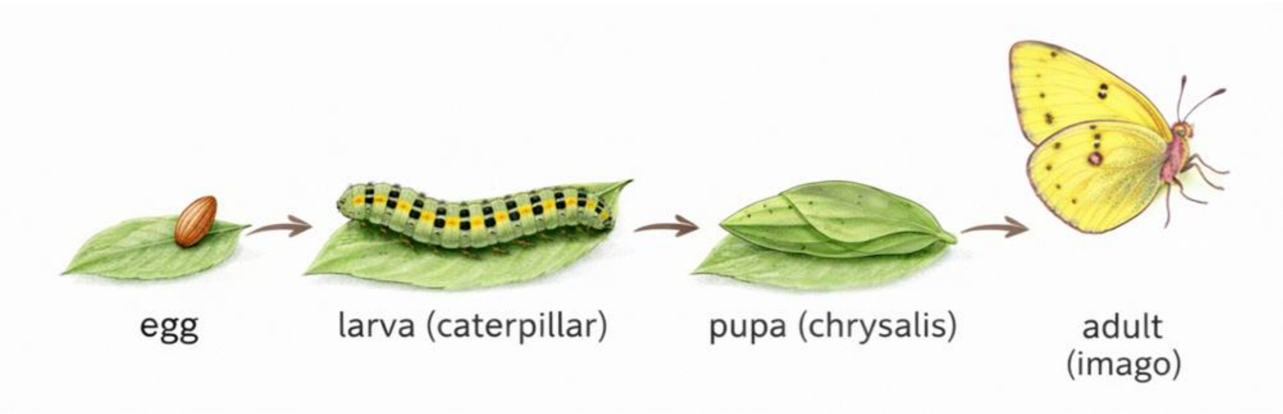
<u>Additional External Resources:</u> do you want to learn more about the butterflies in your area? Visit the following link and download the field guide > https://butterfly-monitoring.net/field-guides

Butterfly life cycle



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Additional External Resources: an example of life cycle of a butterfly can be observed in this publicly available video: [Life cycle of a butterfly 4k HD || From eggs to full grown butterflies || Hugs of life ||]

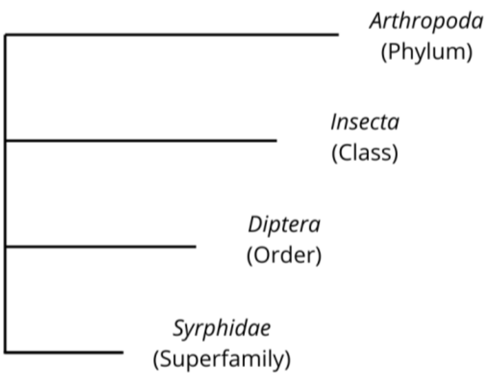
Type of nest

Butterflies need specific plants to complete their life cycle. Eggs are laid on the leaves of host plants, where the caterpillars feed until they transform into chrysalises. These plants provide all the nutrients necessary for caterpillar growth, so they are essential for the survival of each species.

In addition to feeding nectar, adult butterflies need suitable plants on which to lay their eggs, ensuring the next generation has the right food for the caterpillars.

Providing both leafy host plants for caterpillars and flowers for adults allows butterflies to complete their life cycle and supports biodiversity in gardens and natural habitats.

2.4.3 Hoverflies (*Diptera Syrphidae*)



~ 6,000
species worldwide

850 - 900
species in Europe

General characteristics:

- 1° pair of functional wings for flight
- 2° pair reduced to halteres

They seem so similar to bees and wasps because they have developed an evolutionary strategy called Batesian mimicry. It's a phenomenon in which a non-venomous insect (hoverflies) mimics, in its morphology, coloration, or behaviour, another potentially dangerous insect (hymenoptera), in order to appear dangerous in the eyes of predators.

Syrphinae – Episyrphus balteatus
- A very common hoverfly in meadows and gardens
- The larvae feed on aphidsand the adults are excellent pollinators

Microdontinae – Microdon analis
- A rare species
- The larvae live inside ant nests, making these hoverflies difficult to observe

Eristalinae – Eristalis tenax
- It mimics the honeybee
- Has aquatic larvae with a long breathing tube, known as rat-tailed maggots

Pipizinae – Pipiza noctiluca
- A small, dark hoverfly
- The larvae prey on aphids on trees and shrubs, mainly in woodland habitats

(images AI generated)

Additional External Resources: hoverflies are very difficult to identify. If you want more information, visit https://pollinatoracademy.eu/factsheets/hoverfly-genera

2.4.4 Pollinators: only insects?

Although insects are the most efficient pollinators, other animals can also play this role. Many species of vertebrates visit flowers to feed on nectar, pollen, or parts of the plant, and while doing so they meet anthers and stigmas, accidentally transferring pollen.
Unlike insects, these animals are not particularly "precise" and are often larger in size, but they still possess traits that make them suitable: bodies covered in hair or feathers that trap pollen, feeding habits linked to flowers, and the ability to travel long distances in search of food.

These "alternative" pollinators are especially important in certain regions of the world, such as tropical areas, where flowers are often larger, sturdier, and richer in nectar, traits that allow larger vertebrates to visit them without causing damage.

The main non-insect pollinators belong to birds, reptiles, and mammals.

Additional External Resources: An example of non-insect pollinators can be observed in these publicly available videos:

- https://www.youtube.com/watch?v=69ING clp-AZg
- The World's Largest Pollinator Enjoys a Special Treat!
- https://www.youtube.com/shorts/vnqtggv4kXc

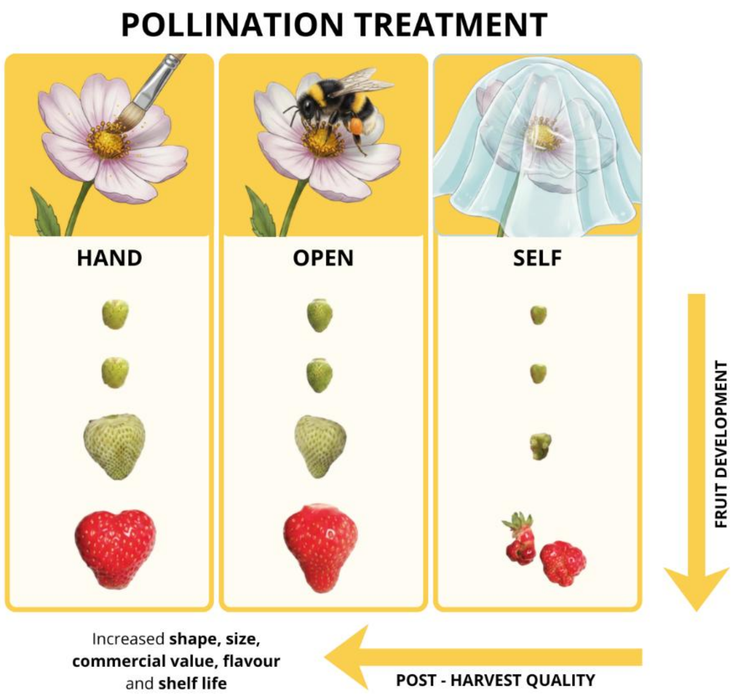
3. Pollinators at risk

Pollinators are essential to healthy ecosystems and global food production, yet many of them are facing increasing threats. Habitat loss, pesticide use, climate change, and pollution are putting growing pressure on these vital insects. Understanding the risks they face is the first step towards protecting them.

3.1 The ecological importance role of Pollinators

Pollinators play a crucial role in terrestrial ecosystems. By transferring pollen between flowers, they ensure plant reproduction, genetic diversity, and the formation of fruits and seeds. This service sustains natural habitats, supports food webs, and directly influences the availability of resources such as fruits, nuts, and forage for herbivores.
In agricultural landscapes, pollinators increase crop yields and quality for many of the world's most nutritious foods, including fruits, vegetables, oilseeds, and nuts. Their contribution is essential for both ecosystem stability and human food security.

Pollinators improve not only the yield of many crops, but also the quality of their fruits.
A plant that benefits from animal pollination typically produces flowers and, after successful pollination, develops fruits containing seeds - this includes not only "fruit" in the common sense (like apples or berries) but also many vegetables such as courgettes, pumpkins, tomatoes and peppers, which are botanically considered fleshy fruits. Insect-pollinated crops generally show better characteristics: fruits tend to be larger, more symmetrical, more intensely colored, and with improved flavor. Their texture and shelf life also benefit from effective pollination.



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3.2 Causes of Pollinator decline

After examining the threats that are endangering pollinators and biodiversity, it becomes clear that action is urgent. For each issue, targeted strategies exist, which can be divided into two categories: conservative measures, aimed at restoring or preserving natural ecosystems, and innovative approaches, developed by humans to create new opportunities for pollinators to survive.

HABITAT LOST / URBANIZATION
Green areas become more uniform and poorer in blooms, leaving pollinators without constant sources of nectar and pollen throughout the year.

Conservation actions:
- Maintaing green areas with spontaneous vegetation
- Reduce mowing frequency
- Adopt lighter, more respectful pruning practices

Innovative actions:
- Create flower beds
- Plant nectar- and pollen-rich species
- Develop vegetable gardens
- Use seed bombs

INTENSIVE AGRICULTURE
Intensive soil management, excessive cleaning of meadows, hedgerows and field margins and the removal of dead wood reduce the spaces where many pollinators nest.

Conservation actions:
- Leave undisturbed, uncultivated and untrampled zones
- Keep small piles of wood or dead branches

Innovative actions:
- Create Bee hotels and artificial nesting structures designed for solitary insects

POLLUTION AND PESTICIDES
The widespread use of pesticides can reduce pollinator survival and alter their orientation, memory, ability to find food and reproduction.

Conservation actions:
- Promote more sustainable agricultural practices
- Reduce the overall use of chemical products

Innovative actions:
- Use biological control methods, natural alternatives to pesticides and integrated pest management

CLIMATE CHANGE
Increasing temperatures and irregular seasonal patterns alter flowering times in plants and the life cycles of pollinators.

Conservation actions:
- Protect intact and diverse ecosystems

Innovative actions:
- Designe ecological corridors
- Create artificial shade areas or water points
- Select drought-resistant or locally adapted plants

INVASIVE ALIEN SPECIES
The introduction of non-native species - such as invasive plants, parasites, pathogens or predators - can harm native pollinators.

Conservation actions:
- Control the spread of invasive species
- Safeguard natural habitats

Innovative actions:
- Participatory monitoring
- Targeted trapping
- Early-warning systems
- Dedicated management plans

What are the effects of these threats?

- **Decline in population numbers:** all these pressures gradually reduce the number of individual pollinators. Fewer insects mean less pollination, putting plants and crops at risk.
- **Loss of species diversity:** the disappearance of many pollinator species threatens the balance of ecosystems. When only a few dominant species remain, plants that rely on specific pollinators may fail to reproduce, and the system becomes fragile: a single event like disease or extreme weather can cause major disruption, reducing ecosystem resilience.

What about honey bees?

The honey bee (*Apis mellifera*) is listed as "Data Deficient" on the European Red List, as it is unclear whether populations in Europe are still truly wild or originating from managed colonies. Over the decades, the species has experienced significant declines due to multiple factors: loss of foraging and nesting habitats, introduction of alien species, spread of pathogens and parasites such as mite *Varroa destructor*, pesticide use. Most colonies are not self-sufficient and rely on human interventions to survive.

Every time we see a honey bee on a flower, it is reasonable to assume that it comes from a beekeeper's hive nearby rather than being part of a truly wild colony.

https://green-forum.ec.europa.eu/nature-and-biodiversity/pollinators-hive_en

We need pollinators and they need our help! See section 4 Let's give Pollnators a helping wing!

3.3 Conservation status and biodiversity decline

Across recent decades, numerous scientific studies have documented a clear decline in both the abundance and diversity of pollinators. As pollinator communities shrink and become more uniform, ecosystems lose resilience, and many plants face increasing difficulties in reproduction. These trends threaten not only wild biodiversity but also global food production, which depends heavily on animal-mediated pollination.

The IUCN (International Union for Conservation of Nature) monitors the conservation status of species worldwide through the Red List. For European pollinators, assessments have shown that many species of wild bees, butterflies, and hoverflies are at risk, with data still incomplete for some populations. Systematic data collection allows the identification of the most vulnerable species, understanding of the main threats they face (such as habitat loss, pesticides, and climate change) and provides scientific guidance for their protection.

Some data from the Red List:

- **Wild bees:** approximately 172 species out of 1,928 assessed are classified as threatened.

  European Red List Bees

- **Butterflies:** 65 species out of 442 assessed are classified as threatened.

  European Red List Butterflies

- **Hoverflies:** approximately 333 species out of almost 900 different species, are threatened with extinction in Europe.

  European Red List Hoverflies

The Habitats Directive (43/92 CEE), adopted in 1992, is a cornerstone of European legislation for biodiversity conservation. It aims to protect natural habitats, wild plants, and animal species through the creation of the Natura 2000 network, which includes Sites of Community Importance (SCIs) and Special Areas of Conservation (SACs). Today, thanks to the Habitats Directive, Europe protects 233 habitat types and 1,389 animal and plant species.

Within the Habitats Directive, Annexes II and IV focus on the protection of habitats and species of Community interest.

3.3.1 Our threatened species

Which pollinator species from your territory are included in the Habitats Directive or listed on the IUCN Red List?

ZOOM TORINO:

- Lycaena dispar (*Lepidoptera Lycaenidae*) > Habitats directive annex II and IV

BRASOV ZOO

COPENHAGEN ZOO:

- Epistrophe grossulariae (*Diptera Syrphidae*) > LC on IUCN Red List, NT on the Danish Red List
- Sericomyia (Arctophila) superbiens (Diptera Syrphidae) > LC on IUCN Red List, EN on the Danish Red List

DEBRECEN ZOO

GOTEBORG ZOO

NORDENS ARK:

- Microdon miki (*Diptera Syrphidae*) > NT on IUCN Red List

ZAGREB ZOO

OASIS WIDELIFE FUERTEVENTURA:

- Gonepteryx cleobule (*Lepidoptera Pieridae*) > VU on IUCN Red List
- Pieris cheiranthi (*Lepidoptera Pieridae*) > EN on IUCN Red List
- Pseudoanthidium canariense (*Hymenoptera Megachilidae*) > DD on IUCN Red List

4. Let's give Pollinators a helping wing!

Understanding the problems is only the first step. To truly support pollinators, we need to turn this awareness into everyday practices and informed design choices. A well-planned flower bed can become a small but valuable refuge, capable of counteracting many of the pressures described in the previous sections.

Take the challenge, give pollinators a helping wing, and create their perfect garden!
How? You've got three fun options:

- make seed bombs and try some guerrilla gardening,
- plant their favourite native flowers,
- build cozy bee hotels.

Show us what you've done and become a true hero for pollinators!
Share your pollinator-friendly project! Tell us what you've created and help pollinators thrive in your community

On the project page, you'll find the map with all the pollinator-friendly areas: have fun finding yours!

The following section presents best practices for creating green spaces that support pollinators throughout their entire life cycle.

4.1 The Bee-friendly Garden Challenge

Pollinators require three main types of habitats to complete their annual life cycle: places to forage, suitable sites for reproduction and safe areas where they can take refuge or overwinter.

An effective design of a pollinator-friendly green space must therefore integrate these three habitat types in a balanced and complementary way, distributed across the site so that insects can easily move between resources and complete their life cycle without interruption.

- **Foraging Habitat (see also 4.2. Creating Seed Bombs: materials, seeds, and methods)**

Foraging habitats ensure the availability of nectar and pollen throughout the entire active season.

What kind of plant should I choose? The "Entomophilous" Plant!

Not all plants reproduce in the same way. While some rely on the wind or water to carry their pollen or self-pollination, entomophilous plants are those that rely on insects for pollination. A plant is entomophilous if it has features that attract insects, for example:

- **Bright and visible flowers** that are easy for insects to find.

- **Abundant pollen (protein) or nectar (sugar),** serving as a “reward” for visitors.
- **Flower shapes suited for insects.**

How can I choose the right entomophilous plant?

- Select native plant species, adapt to the local climate and avoid heavily modified ornamental cultivars.
- Ensure diversity in flower colours, shapes, and sizes to attract different groups of pollinators.
- Provide continuous floral resources from early spring to late autumn.

  Early flowering (late winter – early spring): Crucial for bumblebee queens and solitary bees emerging from hibernation.
  Summer flowering (late spring – summer): The period of highest pollinator activity.
  Late flowering (late summer – autumn): Important for building up energy reserves before winter.

Not sure which plants to choose? Here are our suggestions with flowering periods:

Herbaceous species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Achillea millefolium						X	X	X	X			
Ajuga reptans				X	X	X	X					
Centaurea jacea						X	X	X	X			
Knautia arvensis					X	X	X	X	X			
Viola tricolor					X	X	X	X				
Woody species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Crataegus monogyna					X	X						
Euonymus europeus					X	X						
Frangula alnus					X	X						
Cornus sanguinea					X	X						
Rosa canina						X	X					
Prunus avium				X	X							
Prunus spinosa			X	X								
Calluna vulgaris							X	X	X			
Salix caprea			X	X	X							
Viburnum opulus					X	X						
Ligustrum vulgare					X	X	X					
Rhamnus cathartica					X	X						

Curious about the native plants in your area? Explore https://europlusmed.org/

Which plants should I definitely not plant?

Planting non-native plants - species that originate from other regions or continents - might seem harmless or simply decorative, but it can actually cause significant problems for the environment. In ecology these species are called *alloctone* (non-native), and when they begin to spread aggressively and harm ecosystems they are defined as *invasive*. Not all non-native plants become invasive, but those that do can have serious ecological consequences.

One of the main issues is that many non-native plants grow very quickly and reproduce efficiently. In their original habitats they are kept in balance by natural predators, diseases, and competition with other species. When introduced into a new environment, however, these natural controls are often absent. As a result, the plants can spread rapidly and dominate the landscape. This aggressive growth allows invasive species to outcompete native plants for essential resources such as sunlight, water, nutrients, and space. Native plants have evolved over thousands of years within a specific ecosystem and often grow more slowly or depend on delicate ecological relationships. When an invasive species takes over an area, it can crowd out these native plants, sometimes forming dense monocultures where very few other species can survive. This process drastically reduces biodiversity.

The loss of native plants also affects wildlife. Many insects, birds, and other animals rely on specific native plant species for food, nesting sites, or shelter. For example, numerous insects have co-evolved with particular plants and cannot feed on unfamiliar species. If those native plants disappear, the insects decline as well, which in turn impacts birds and other animals that feed on them. In this way, invasive plants can disrupt entire food webs.

For these reasons, we strongly encourage the use of native plants in gardens, parks, and restoration projects. Native species support local biodiversity, provide food and habitat for wildlife, and help maintain the natural balance of ecosystems. Choosing native plants is therefore not only a landscaping choice, but also a way to actively contribute to the protection of local environments.

These are some of the non-native and invasive plants you must avoid:

Buddleja davidii

Also known as the butterfly bush, this ornamental plant comes from China and is popular for its showy, sweet-smelling flowers. Despite attracting many insects, it spreads very easily and can take over natural areas, pushing out native plants.

Oenothera speciosa

This flowering plant originates from North America and is admired for its large, pale pink flowers that open mainly in the evening. While it may seem pollinator-friendly, outside its natural range it can cause harm: its flower shape is not always suitable for local insects and may even trap some moths.

Lonicera japonica

The Japanese honeysuckle is a fast-growing climbing plant from East Asia, loved for its fragrant flowers. However, it can quickly become invasive, covering other plants and reducing space for native species.

(Photo credits: Marion Wildegger Bitz – Pixabay; Thanasis Papazacharias - Pizabay; Tsuga - Pixabay)

- **Nesting Habitat (see also 4.3 Building a Bee Hotel: A 5-Star Experience for Pollinators**

Nesting habitats are essential for pollinators to lay eggs, build nests, and complete their larval development. Requirements vary depending on the insect group.

For bees (above all solitary species):

Ground-nesting (about 70% of species):

- Areas of well-drained wasteland
- No artificial mulches, preferring natural ones (straw, hay, wood chips, dry leaves)
- Do not disturb the soil: avoid ploughing the soil, prefer aeration with a rake to avoid inverting the soil layers.

Cavity-nesting (about 30% of species)**:**

- Dead wood, old logs, stumps, and hollow branches
- Possibility to integrate properly designed bee hotels (variable diameters, natural materials, appropriate depth, correct orientation).

For butterflies and other Lepidoptera:

- Specific host plants for egg-laying and caterpillar development (not just nectar plants!). The eggs are usually attached to the underside of leaves, which will become food for the caterpillars.

- Presence of nettles, brambles, grasses, and spontaneous vegetation, essential for many species.

For hoverflies:

Eggs are laid near a suitable food source for the developing larvae, which, depending on the species, can be found in different places:

- on sick plants or leaves infested with aphids, since many larvae feed on aphids;
- in standing water or damp soil;
- in decaying wood or rotting plant material, in the case of saprophagous species.

➢ **Shelter & Overwintering Habitat (see also 4.3 Building a Bee Hotel: A 5-Star Experience for Pollinators)**

Overwintering habitats provide shelter and protection to pollinators during adverse seasons and are essential for the completion of their life cycle.

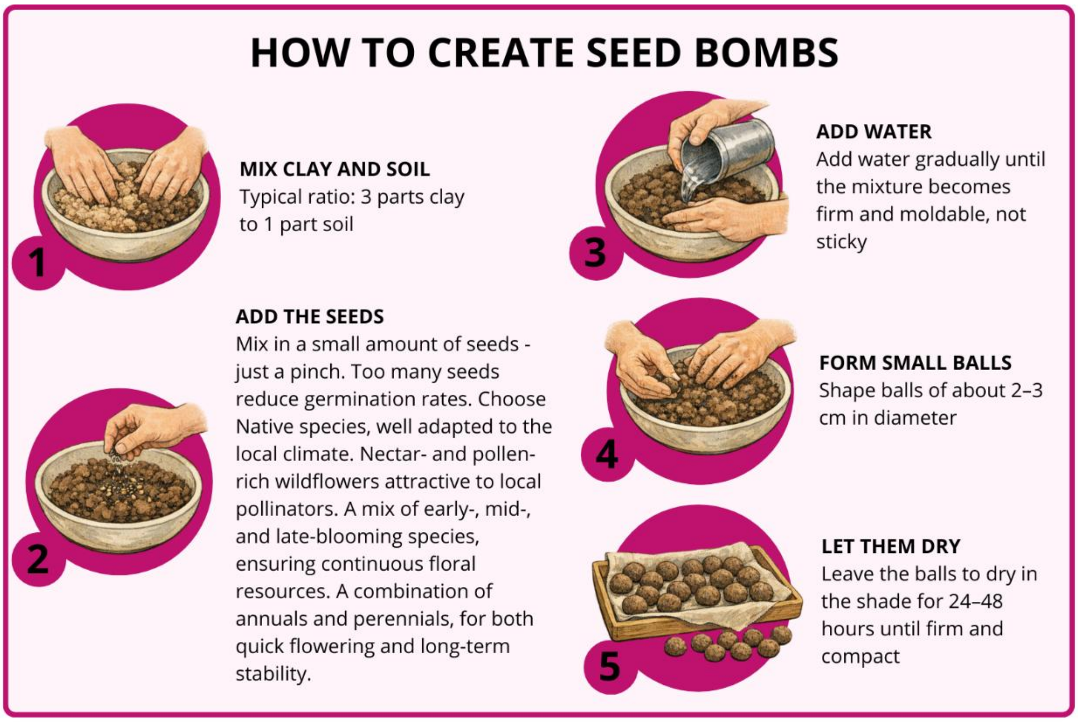
Insects overwinter in different places such as meadows, ditch or roadside edges, shrubby clusters, hedges, isolated tree cavities, wood piles, leaf litter (decaying leaves) and in the soil.

It is recommended:

- to avoid autumn clearing and to leave dead stems and flower heads standing during the winter.
- Mowing should be scheduled to allow pollinators to complete their cycle and not destroy shelter sites.
- It is useful to maintain small piles of brushwood to provide cover against predators, such as bumblebees.

4.2 Creating Seed Bombs: materials, seeds, and methods

Seed bombs are a simple and effective way to promote the spread of wildflowers that support pollinators, especially in areas that are difficult to access or frequently disturbed. The idea is to encase seeds in a mixture of clay and soil, which protects them from drying out, wind, and birds, allowing them to germinate when conditions become favorable.



(images AI generated)

Where?

Seed bombs should not be thrown everywhere. They must be used only where seeding is ecologically appropriate.

Suitable locations:

- Degraded or marginal areas (slopes, field edges).
- Poorly maintained urban spaces, such as abandoned parking strips or cycle path edges.
- Hard-to-reach or erosion-prone sites.
- School gardens or community areas where increasing biodiversity is a goal.

When?

Best seasons for dispersal:

- <u>Early spring</u>: ideal for annual and spring-germinating perennials.
- <u>Autumn</u>: excellent for perennials that require winter cold (vernalization) to germinate.

Be Patient: first leaves usually appear within 2–6 weeks, depending on species and weather.

It is normal for some seed bombs not to germinate; a portion may remain dormant or be lost maybe because it serves as food for wildlife.

4.3 Building a Bee Hotel: A 5-Star Experience for Pollinators

Imagine a 5-star hotel for insects, where every detail is designed to offer safety, comfort, and a perfect stay. Bee hotels work exactly like that: private rooms for winter rest, secure suites for laying eggs, and a variety of chambers tailored to different species. Some guests come for the lodging, others for the restaurant - and all contribute to a vibrant, functional ecosystem.

Why?

Think of a bee hotel as a boutique resort with different purpose:

Seasonal Suites: Overwintering Rooms

Some insects use the bee hotel as a winter retreat, a safe shelter where they can spend the cold season. Like a hotel with natural heating, the cavities must be dry, protected, and deep enough to ensure comfort throughout winter.

Nesting Rooms

For solitary bees and other pollinators, the bee hotel also serves as an exclusive nursery, where they can lay and protect the eggs of the next generation. Blind, smooth corridors act as “private suites” that allow guests to develop safely. The angle of the holes and protection from wind and rain ensure that every room stays dry and functional.

The Restaurant: Flower Buffet

No luxury hotel is complete without a restaurant! Nearby flower beds and blooming plants offer nectar and pollen - the favourite food of our winged guests. The placement and orientation of the hotel must make access to these resources easy, like hallways leading straight to the buffet.

Variety of Rooms: Catering to All Guests

Just like a hotel hosting different kinds of clients, it’s helpful to provide rooms of various shapes and sizes to accommodate multiple species at once:

- Solitary bees: tubes and blind corridors 12–20 cm deep, diameter 2–12 mm, smooth materials like bamboo, drilled wood, or clay.
- Ladybirds and lacewings: sheltered cavities filled with straw, protected entrances.
- Butterflies and chrysalises: small chambers with a door and vertical slits, plus dry stems for perching.
- Other guests: pinecones, dry leaves, snail shells, stones, or corrugated cardboard to offer small, secure hiding spots.

How?

As in any high-quality hotel, the structure must be solid, stable, and well positioned:

- Recommended height: at least 1.5 meters above ground, mounted on a post or sturdy tree.
- Orientation: ideally facing South or East to enjoy warmth and sunlight.
- Protection: sheltered from wind and rain, with a waterproof roof and robust frame.
- Fixing: firmly attached to avoid falls or swinging.
- Cleaning: once a year, at the end of summer, inspect and replace rooms if needed to prevent mold and parasites.

Be careful!

- **It supports only a few species:** only cavity-nesting bees benefit; about 70% of bees nest underground → undisturbed soil is essential too.
- **Risk of overcrowding:** too many rooms in the same spot increase competition → better several small hotels spread out.
- **Higher pressure from parasites and mold:** high nesting density favours mites, cleptoparasites, and mold → regular maintenance is needed.
- **Often made with poor materials:** shallow structures, rough holes, plastic inserts, water infiltration → a “fake hotel” can be more harmful than helpful.

Is my bee hotel being used?

(Photo credits: Fondazione ZOOM)

To check if a bee hotel is in use, simply count the sealed tubes: they can be sealed with mud, resin, leaves, petals, or chewed plant fibers. It’s easiest to see sealed tubes from late spring to early autumn. In winter, it’s normal for the bee hotel to look inactive, because the larvae are developing inside.

You can also observe if insects are visiting the tubes: are they bringing materials, entering to lay eggs, or guarding a nest?

They lay their eggs only in spring and summer.

The larvae - and later the pupae - stay sealed inside the bee hotel for many months, spending autumn and winter in their nest and feeding on nectar and pollen that the mother left behind when she laid the egg.

The adult bee will emerge the following spring, when flowers are abundant enough to support it.

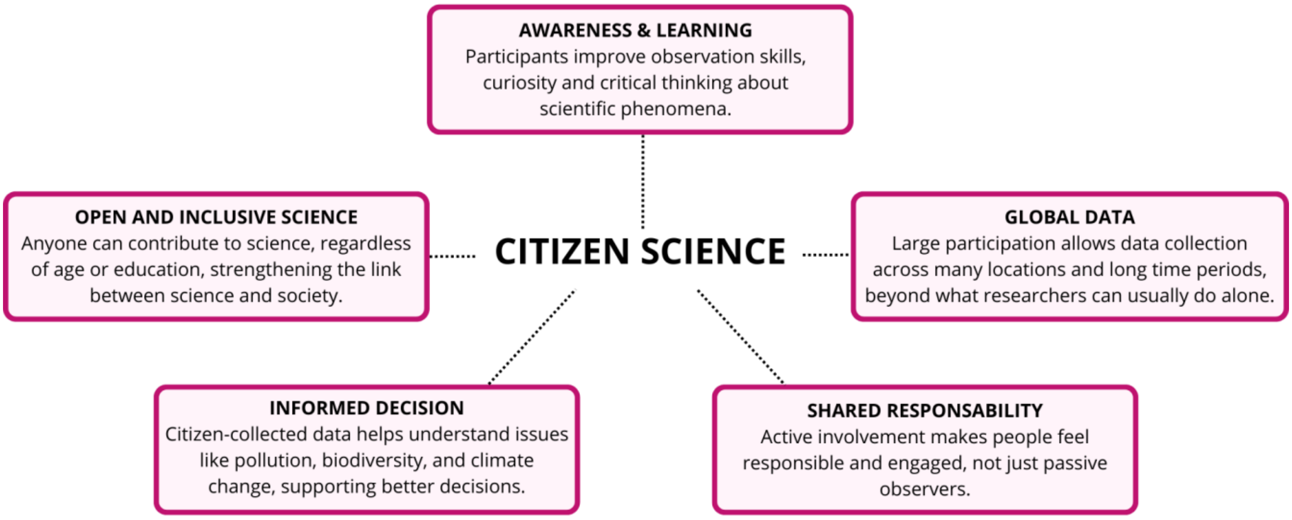
What if my bee hotel is not being used?

Don't worry, it can happen. Try these simple adjustments:

1. Improve the placement: put the bee hotel in a sunny spot, facing south or southeast, protected from rain and strong wind.
2. Add floral resources: plant or keep nearby nectar- and pollen-rich flowers, especially native species that bloom from spring to summer.
3. Check the nesting materials: make sure the tubes are clean, smooth, and 12–20 cm deep, with diameters between 2–12 mm.

4.4 Citizen science

Citizen science is a way of doing scientific research that involves ordinary people, not only professional scientists. Citizen science is important because it brings science closer to people and makes people active contributors to knowledge, creating shared understanding and greater awareness and therefore protection of the world around us.
Citizens can take part by collecting data, making observations, using apps, or joining projects about the environment, health, or society.



4.4.1 iNaturalist

One of the apps that can be used for citizen science is iNaturalist, a free app that helps people observe, identify, and share the nature around them. It is used all over the world by citizens, students, teachers, and scientists.

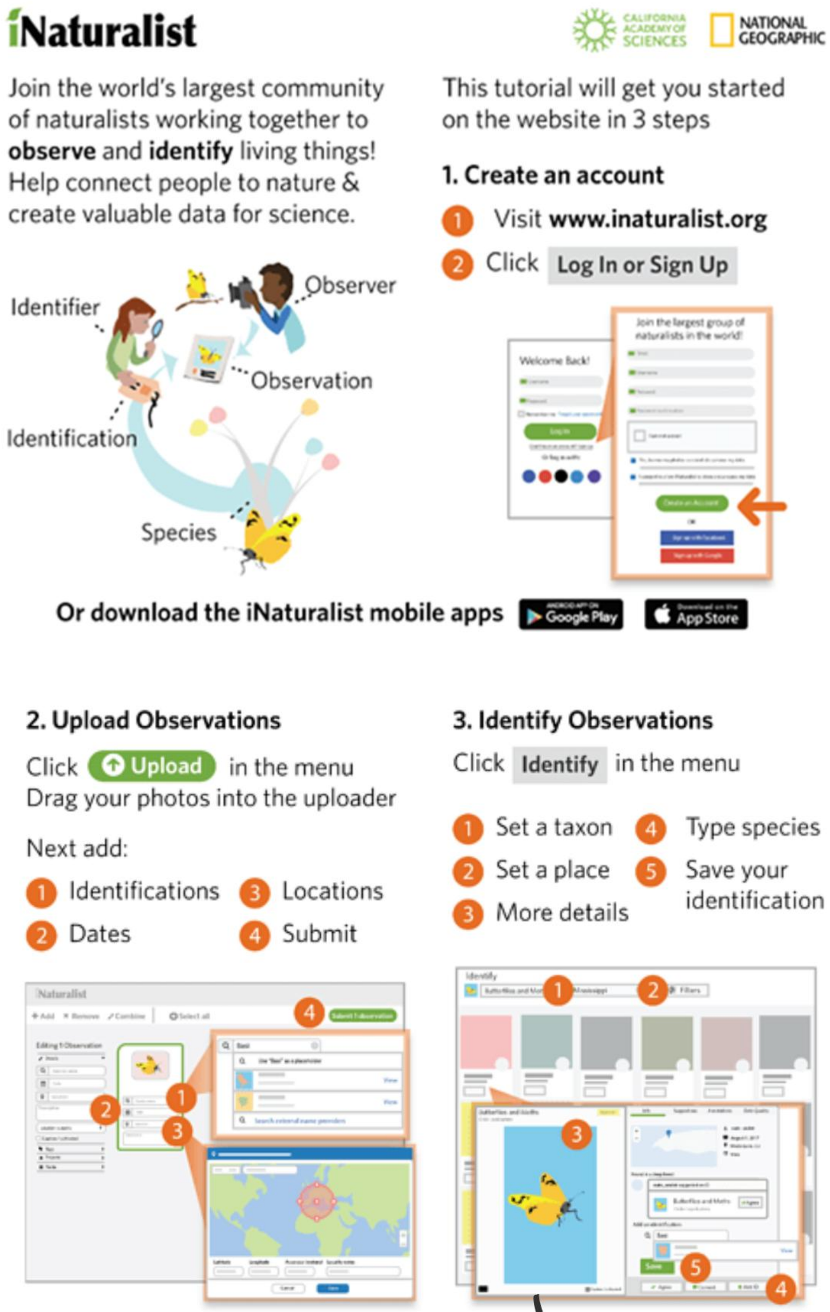
With this app you can:

- Take photos of plants, animals, and fungi: just take a picture with your smartphone during a walk, in the city or in nature.

- Get help with identification: the app suggests the name of the species using artificial intelligence and support from a community of experts and nature enthusiasts.
- Share your observations and contribute to scientific research.

Within iNaturalist, we have created the Zoo Life Pollinators project, which you can join to photograph insects near partner zoos and help us record and monitor the most common species.

[Click here and join our citizen science community]



The app suggests an automatic identification: you can accept it, leave it as "Insecta" or try to identify it.

4.4.2 ButterflyCount app

Another citizen science initiative promoted by Butterfly Conservation Europe is the European Butterfly Monitoring Scheme – eBMS. This project was created to better understand the health of butterfly populations across Europe and the crucial role they play in ecosystems.

To make participation easy, immediate, and engaging, an application has been developed for everyone. The app, called ButterflyCount, allows users to contribute to the monitoring effort in a simple and fast way: participants can photograph the butterflies they observe, automatically record their geographic location, and enter a few key details useful for data collection.

Monitoring within this project follows a specific transect method, which ensures that the data collected are scientifically robust and comparable over time. For detailed instructions on how to carry out the surveys correctly refer to Pollinators monitoring Handbook document.

4.4.3 Capturing the perfect shot

It is not necessary to have photographic skills or professional equipment to document the world of insects. Both a camera and a smartphone can be used: the important thing is to obtain clear images that are useful for observation and identification.

- **Find the insects: when, where and how**
    - Spring and summer are the most suitable seasons for observation.
    - Most pollinators are more active during warm, sunny, and low-wind conditions, typically from late morning to early afternoon.
    - Early in the morning or late in the evening, insects are generally calmer and less “frenetic”. However, the central hours of the day are period when it is easier to observe a higher number of insects.
    - Insects are more easily found near flowering plants, hedgerows, grasslands, urban green spaces, and other habitats that provide food and shelter.

- **Photograph the insect as a whole and check the Angles**
    - Try to take at least one photo showing the entire animal, including the antennae if visible.
    - Try to take several images from different angles: top-down (dorsal) view and side (lateral) view.

- **Pay attention to focus**
    - Make sure the insect is in focus and not blurred. If the smartphone has difficulty focusing, it may help to move slightly closer to or farther away until a sharper image is obtained.
    - Use macro mode if possible: it is necessary to get very close to the subject (approximately 3–5 cm).
    - Holding your breath while taking the photo can help reduce camera shake

- **Do not scare them away**
  - Approach slowly to avoid scaring the insect: getting too close to insects may frighten them and cause them to fly away.
  - Watch Your Shadow: keep the sun in front of you; take care not to cast a shadow on them with your body.

Remember: take 10 photos, so at least one will be usable!

4.4.4 Materials and tools for field observation

If you are in the field and prefer not to use electronic devices to enter photos directly, you can bring a data collection sheet like the one in the next page with you.

ZOO LIFE pollinators

The future is on their wings.

BUTTERFLY MONITORING SCHEME
FIELD SHEET

TRANSCENT NAME ______ OBSERVER ______

DATE ______ WEEK ______ START TIME ______ END TIME ______

START/ END TEMP (°C) ___ / ___ START / END WIND SPEED BEAUFORT SCALE ___ / ___

AVERAGE TEMP (°C) ______ AVERAGE WIND SPEED BEAUFORT SCALE ______

BEAUFORT SCALE: 0 - Calm, smoke rises vertically; 1 - Smoke drift indicates wind direction, still wind vanes; 2 - Wind felt on face, leaves rustle, vanes begin to move; 3 - Leaves and small twigs constantly moving, light flags extended; 4 -Dust, leaves, and loose paper lifted, small tree branches move; 5 - Small trees in leaf begin to sway

SECTIONS

SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL
TOTAL											

Average cloud cover

CLOUD COVER											

NOTES:

We are carrying out a census of the most common pollinators recorded during the Zoo Life Pollinators project; for now, you can find comprehensive lists and identification guides at the following links:

- **Bees and hoverflies**: https://pollinatoracademy.eu/
- **Butterflies and moths**: https://butterfly-monitoring.net/it/guide-da-campo

If you want to know more about how identify pollinator insects, search in the Pollinators monitoring handbook for the identification keys.

4.5 Choose eco-certified food

There is another way to help pollinators: buying **eco-certified food** is a simple but powerful way! Eco-certifications, such as those promoted by organizations like Rainforest Alliance, Fairtrade International, and European Union Organic Certification, often require farming practices that reduce pesticide use, protect natural habitats, and encourage biodiversity. These practices create safer environments where pollinators can find food and nesting sites.

But how can we recognize eco-certified food? The easiest way is to look for official certification labels on the packaging. Many products display recognizable logos showing that the food was produced according to environmental standards like these:

Rainforest Alliance | European Union Organic Certification | Fairtrade International

These labels are granted only after farms and supply chains are checked against sustainability criteria, including reduced pesticide use and protection of biodiversity. By paying attention to these certifications when shopping, consumers can support farmers who manage their land more sustainably and help create healthier ecosystems for pollinating insects.

5. Pollinators, the 2030 Agenda and UE actions to protect them

5.1 Onu 2030 Agenda

The 2030 Agenda for Sustainable Development is a global plan adopted by the United Nations in 2015. It was created to guide countries, organizations, and communities toward a more sustainable, fair, and healthy future for people and the planet.

At the heart of the Agenda are 17 Sustainable Development Goals (SDGs). These goals address some of the world's most important challenges, such as protecting nature, fighting climate change, reducing inequality, improving health and education, and ensuring access to clean water and food.

The Agenda is based on a simple but powerful idea: everything is connected. Human well-being depends on a healthy environment, strong communities, and responsible use of natural resources. For this reason, the SDGs combine social, environmental, and economic goals.

The 2030 Agenda is universal, meaning it applies to all countries, not only developing ones. Governments, cities, businesses, schools, and individuals are all encouraged to take action. Even small, everyday choices - like protecting biodiversity, reducing waste, or supporting sustainable practices - can make a difference.

Linking Actions to SDG Goals

Pollinators are directly connected to several Sustainable Development Goals - not in a theoretical way, but in a concrete, measurable one.
Here's the simple logic:

- **SDG 2 – Zero Hunger:** without pollinators, many crops experience a sharp decline in yield. Protecting them means protecting food security.
- **SDG 11 – Sustainable Cities and Communities:** flower beds, ecological corridors, and nature-based urban management improve quality of life.
- **SDG 12 – Responsible Consumption and Production:** fewer pesticides, more sustainable farming practices.
- **SDG 13 – Climate Action:** monitoring pollinators helps us understand how climate change is reshaping ecosystems.
- **SDG 15 – Life on Land:** habitats, biodiversity and threatened species - at the core of pollinator protection.

A local action (a flower bed, a bee hotel, a monitoring effort) can support several goals at once, making them visible and measurable.

SDG	Connection to Pollinators	Example Action
2 ZERO HUNGER	Pollinators support crop yields	Protect local pollinators to secure food
11 SUSTAINABLE CITIES AND COMMUNITIES	Urban nature improves quality of life	Plant flower beds, create bee-friendly spaces
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Sustainable farming & reduced pesticide use	Adopt pollinator friendly practices
13 CLIMATE ACTION	Pollinator monitoring reveals climate impacts	Track pollinator populations in cities
15 LIFE ON LAND	Protects habitats and biodiversity	Restore natural areas for pollinators

5.2 Connections to EU initiatives and useful resources

EU Pollinators Initiative - Action plan with monitoring and recovery measures

This is the EU's action plan to address pollinator decline and protect wild pollinating insects. In 2025 it was updated with binding targets: Member States must launch standardized pollinator monitoring and adopt measures to support population recovery.

https://environment.ec.europa.eu/topics/nature-and-biodiversity/pollinators_en

EU Biodiversity Strategy 2030 - Targets for habitat restoration, pollinator-friendly environments

A roadmap to protect and restore nature in Europe by 2030. It includes targets for ecosystem and habitat restoration, many of which are essential for ensuring healthy environments for pollinators and other wildlife.

https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en?

Common Agricultural Policy (CAP) - **Incentives for sustainable farming & pollinator habitats**

In its 2023–2027 framework, the CAP includes tools and incentives for sustainable agriculture and pollinator-friendly practices (non-productive areas, flower strips, organic farming, and proper land management), helping create and maintain habitats for both wild and managed pollinators.

https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/biodiversity_en?

European Pollinator Monitoring Scheme (EU-PoMS) - **Standardized data collection for trends and conservation**

This system, mandated by recent EU legislation, standardizes the collection of data on pollinator diversity and abundance across Member States, to track long-term trends and assess the effectiveness of conservation measures.

https://environment.ec.europa.eu/news/better-monitoring-support-restoration-eu-pollinators-2025-11-26_en?

5.3 EU strategies to reduce pollinators decline

Year	Action	About it
2018	Adoption of the EU Pollinators Initiative (first coordinated EU initiative specifically for wild pollinators) (commission.europa.eu)	First European strategic framework to address the decline of wild bees, butterflies, hoverflies, etc. Objective: improve knowledge, conservation, and public engagement (europarl.europa.eu)
2020 - 2023	Inclusion of pollinator protection in the broader EU Biodiversity Strategy for 2030 (environment.ec.europa.eu)	EU-wide goal to reverse pollinator decline by 2030 (eea.europa.eu)
2023	Review of the EU Pollinators Initiative - new “deal for pollinators” (environment.ec.europa.eu)	Updated priorities and concrete actions: improved monitoring, conservation, societal engagement, and agricultural policies supporting pollinators (eumonitor.eu)
19 aug 2024	Entry into force of the Nature Restoration Regulation	Member States are required to reverse pollinator decline by 2030 and monitor populations and biodiversity through a European monitoring mechanism (environment.ec.europa.eu)

nov 2025	Launch of the EU Pollinator Monitoring Scheme – EU-PoMS (italy.representation.ec.europa.eu)	Provides regular data on pollinator abundance/diversity, measures the effectiveness of restoration actions, and informs future policies
2020 - 2025	LIFE and national projects: e.g., Zoo Life Pollinators	Territorial interventions to restore habitats, biodiversity, native flowers, and nesting sites to counter habitat loss and species decline
22 - 29 sep 2025	First session of the Young Citizens Assembly on Pollinators	Direct involvement of youth, citizens, and stakeholders to propose concrete ideas and solutions for pollinator conservation and biodiversity

6. Educational activities

This section gathers all the activities in the toolkit designed to support teachers' work. The proposals are organized by age group and educational objectives, allowing you to quickly identify the activities best suited to your class group.
Each activity is presented with a concise operational sheet that includes: objectives, implementation guidelines, and potential challenges that may arise during group management.

6.1 Early-childhood / Primary School Activities

Games and Hands-On Activities

- *Game*: "Giant ruler"

- *Game*: "Am I an insect or not?" - Recognizing basic insect traits
- *Game: "Sort them all!"* - classifying the main pollinators families
- Understanding pollination: from flower to...
- *Game*: "Am I a pollinator or not?" (with a focus on zoo species)
- Watching pollinators at work - Pollinator monitoring activities for school gardens or zoo visits

Educational Materials

- Collectible pollinator cards to build a "Garden Visitors Album"
- Printable sheets of main pollinating insects with anatomical parts to assemble in 3D models

Interactive Learning

- **Pollinator Escape Room - Solve the challenges. Help pollinators survive.**
- **Coding Activities** using tiles representing goals (flowers, shelters) or obstacles (pollinator threats)

6.2 Secondary School Activities

Scientific activities

- From Observation to Classification
- *Game*: "Am I a pollinator or not?"
- Pollination strategy (Flower dissection and microscopic observation of pollen)
- Watching pollinators at work - Pollinator monitoring activities for school gardens or zoo visits

- Data re-elaboration methods

Role-playing and Discussion

Simulation activity

- Role-playing exercise where students represent different stakeholders (farmer, environmentalist, citizen, local authority, agricultural company)
- Debate on real issues affecting pollinators, working toward shared solutions

Integration with existing resources

- Activities aligned with educational materials provided by zoos and citizen science projects
- Reference to the *Inventory of Educational and Citizen Science Initiatives for Pollinators*

6.3. Early childhood and primary school

How to use this section:

The activities are grouped by educational objectives, allowing for flexible use of the toolkit.

They are suitable for both early childhood and primary school: each activity sheet provides suggestions for adapting instructions, language, and timing.

For every activity, you will also find a short section outlining the main difficulties that may arise in the classroom, along with practical tips to address them.

GIANT RULER

Target: Early childhood / Primary school
Duration: 10–15 minutes
Materials: None (optional: a rope or tape on the floor to mark the "ruler")

Objectives:

- Encourage active participation through movement.
- Stimulate curiosity about insects and nature exploration.
- Help children express perceptions, experiences, and prior knowledge.
- Support teachers in quickly assessing the group's familiarity with the topic.

Brief description:
Children position themselves along an imaginary giant ruler on the floor, representing a scale from *very little* to *very much*.
The teacher asks questions related to insects, experiences in nature, or previous observations. Children move to the point on the ruler that best represents their answer.

Examples of question:

- *How much do you like insects?*
- *How much do insects scare you?*
- *How much do you like walking in the meadow?*
- *How much do you enjoy exploring nature?*
- *How curious are you to discover insects?*
- *How excited are you to start this adventure?*

For each question, children can be asked to provide more details. This way, we can gather information about their willingness to participate in the activity, their prior knowledge, and any fears they may have. This will help us know what to focus on to ensure the activities are successful.

Possible challenges:

- Children may crowd in the same area and struggle to find space.
- Some may feel shy about taking a position if their answer differs from the group.

Tips and adjustments:

- Define the ruler clearly on the floor (rope, tape, or cones) to avoid confusion.
- Normalize all answers ("There's no right or wrong place—everyone has different experiences").
- For early childhood: keep questions simple and concrete.
- If we think the children may not know exactly what insects are (there is a specific activity about this later in the text), we can start with a quick round in which each child names an insect they know. We can suggest that insects are small animals that fly, and if a child mentions an animal that is not an insect, we gently correct them.

AM I AN INSECT OR NOT?

Target: Early childhood / Primary school
Duration: 15–30 minutes
Materials:

- Image cards of various animals (insects and non-insects)
- Two boxes labelled *“Insect”* and *“Not an insect”*
- Optional: realistic photos, 3D plastic insect models, projector, puppets/plushies

Objectives:

- Recognise the basic anatomical features of insects.
- Develop observation and comparison skills.
- Learn to classify animals based on clear criteria.
- Encourage group reasoning and shared decision-making.
- Build familiarity and reduce fear or discomfort around insects.

Brief description:

Children explore what makes an insect an insect.
Using images, realistic photos, or 3D models, the educator introduces the key body parts (head, thorax, abdomen, six legs, antennae, wings) and compares them with human body parts and functions.
For deeper knowledge, teachers are directed to Section 2 of the Toolkit.

All insects have got 6 legs, 3 pairs. This is the main character that we have to consider.

Each child receives a card showing an animal. They examine it carefully and place it into the correct box: *Insect* or *Not an insect*. It’s not very important to know the animal exactly, just count the legs, if there are 6, it’s an insect!
A simplified version involves projecting one image at a time and discussing together before moving to independent classification.

Examine all together the answers focusing on the method of classification (6 legs).

Possible challenges:

- Some children may confuse insects with spiders or other small animals.
- Younger children may struggle to focus on small anatomical details.
- Shy children may hesitate to place their card if unsure.

Tips and adjustments:

- Start by identifying the main insect features on a large picture or model.
- Use clear visual contrasts (e.g., an insect vs a spider) to reinforce criteria.
- Emphasise counting the legs as a simple, reliable strategy.
- Normalise mistakes: “We’re all learning!”

For 5-year-olds:

- Count the legs together and decide as a group.

For younger children:

- Provide only true insect cards so they can familiarise themselves with a variety of insect shapes. The children can also try to describe the colour and the shape of the insect. You can also select only the most famous insects: bees, butterflies, flies and ladybug. Follow next chapters for more details.

For primary school:

- Add questions about their experience with the insects on the cards.

SORT THEM ALL!

Target: Primary school

Duration: 20–30 minutes (depending on age and number of examples).

Materials

- The same cards used in the previous activity (duplicated, without intruder animals) or
- Printed images of insects from the web or
- Sets of 3D plastic insect models
- Four boxes or trays labelled Bees – Butterflies & Moths – Beetles – Flies, or large representative photos (recommended for early years).

Objectives

- Learn to recognize the main groups of pollinating insects using simple, reliable traits.
- Develop observation and classification skills.
- Consolidate the understanding of insect diversity among pollinators.

Content overview (Teacher notes)

Key identification traits:

- **Butterflies & moths:** wings are coloured, white, or grey — **never entirely transparent;**
- **Beetles:** front wings form a **hard shell** ("little backpack") covering the folded wings;
- **Flies: 2 transparent wings**;
- **Bees: 4 transparent wings**; **yellow and black stripes** are common

Activity procedure

1. **Introduction (2–3 min)**
   Remind children that not all insects are pollinators, but many important groups are. Explain that today they will learn how to distinguish them using very simple clues.

2. **Explain the key traits (5 min)**
   Present each group with a picture or model. Show the distinctive features: number of wings, colours, wing shape, shell, stripes, etc.

3. **Classification game (10–15 min)**

   - Give each child an insect card or a plastic model.
   - Ask them to look closely and decide **which category it belongs to**.
   - Invite them to place their insect in the correct box or in front of the large representative photo.
   - Repeat using new cards if time allows.

Extensions for older children

- **Bees vs wasps:** body shape, hairiness, colours
- **Hoverflies:** flies mimicking bees; why mimicry is useful
- **Butterflies vs moths:** antenna shape, resting wings, day/night activity

Variations

- **Speed round:** children classify quickly in teams.
- **Outdoor version:** with supervision, children observe real insects and try to identify the group.
- **Focus groups**: to explore each insect group in more depth, you can create small rotating *focus groups*: set up four stations, one for each group (bees, butterflies, flies, and beetles). Children, divided into small groups, rotate among the stations, observing and classifying the insects at each one. This way, each group can focus on a limited set of characteristics, encouraging more careful and targeted observation.

Tips & recommendations

- For younger children or preschoolers, use **big images/puppets/plushies** rather than written labels.
- Plastic models don't need to be realistic in detail – for classification by major groups, they work fine.
- Reinforce learning by repeating the same simple rules multiple times.

FROM FLOWER TO...

Target: Early childhood / Primary school

Duration: 20–30 minutes

Materials:

- 3D model of a flower (can be store-bought, homemade, or paper model)
- Model of a pollinator insect (3D plastic, plush toy, or DIY with recycled materials)
- Optional: pictures or cards of flowers and insects and videos

Objectives:

- Learn the main parts of a flower and a pollinating insect.
- Understand why insects visit flowers.
- Observe the process of pollination step by step.
- Understand the connection between pollination and fruit/seed formation.
- Develop curiosity and reasoning.

Activity procedure:

1. **Introduction to the flower and insect:**

    - Show the flower model and review or introduce the names of its parts (petals, stamen, pistil, nectar).
    - Show the insect model and discuss its main parts (head, thorax, abdomen, wings, bristles).
    - Ask the children to point and name each part.

2. **Why do insects visit flowers?**

    - Ask the children: *"Why do insects go to flowers?"*
    - Guide them to the idea that insects come to feed on nectar.

3. **Finding the nectar:**

    - Ask children where they think the nectar is located.
    - Let them guess freely at first.
    - Discuss their answers and explain why only the bottom of the flower (the "bowl" formed by petals) contains nectar.
    - Address possible objections: e.g., "Wouldn't the nectar spill out?" – explain with analogy (even non-waterproof surfaces can hold small amounts of liquid).

4. **Pollinator in action:**

    - Move the insect model to the correct position in the flower.
    - Explain what happens: while the insect is feeding the pollen sticks to the bristles, like flour on hair.
    - Ask: *"What happens next? Why does the insect go to another flower?"*
    - Explain that when the insect visits another flower (always for feeding!), the pollen reaches the pistil and fuses with the ovules.

5. **Outcome of pollination:**

    - Ask: *"What does the flower become?"*
    - Explain that flowers with pollen in the pistil turn into fruits containing seeds, which will grow into new plants.
    - Highlight the purpose: plants "invite" insects to transfer pollen and produce seeds, it's not a voluntary work on the part of insects

Possible challenges:

- Younger children may confuse parts of the flower or insect.
- Some children may struggle to grasp the link between pollen transfer and fruit formation.
- Children may focus only on the insect and forget the plant's perspective.

Tips and adaptations:

- Use a **large flower model** for preschoolers to allow hands-on exploration.
- Encourage children to **simulate insect movement** themselves for kinaesthetic learning. You can mime the whole process by having the children play the various parts of the flower, while some are the insects.
- For older children, introduce concepts like **cross-pollination** and **species specificity**.

AM I A POLLINATOR OR NOT?

(with a focus on zoo species)

Target: Primary school

Similarly to the game **"Am I an insect or not?"**, children are presented with a series of **animal cards**. For each card, they are asked to decide whether the animal shown is **a pollinator or not**.

The cards include:

- **Insect pollinators** (bees, bumblebees, butterflies, etc.)
- **Non-pollinating insects**, often carnivorous or predatory species that do not visit flowers
- **Birds and mammals**, some of which are pollinators (such as bats or certain nectar-feeding birds), others not (every zoo can choose some of their animals)
- Optionally, **reptiles or unusual species**, to further stimulate curiosity and discussion

During the activity:

- When focusing on **insects**, children can be guided to reason about their **diet** (Do they feed on nectar? Do they visit flowers?).
- For **mammals, birds and reptiles**, children may rely more on intuition unless there is a particularly knowledgeable participant.

This is not a problem, as the specific aim of this activity is **not to assess learning outcomes**, but rather to:

- **spark curiosity**
- **create a sense of surprise** by showing that pollinators are not limited to insects
- broaden children's understanding of pollination beyond the most familiar examples

In this way, surprise becomes a powerful educational tool, helping to engage participants and prepare them for the activities that follow while reinforcing interest in biodiversity.

Notes for zoo educators

This activity offers a valuable opportunity to **connect pollination to animals that children can actually observe in the zoo**.
Zoo educators can emphasize that pollinators are not limited to insects in the wild, but include **birds and mammals that are often part of zoo collections**, such as bats, nectar-feeding birds or other small mammals.

Educators may:

- Invite children to **recall animals they have already seen** in the zoo and ask whether any of them could act as pollinators.
- Briefly explain **how pollination happens in these species** (for example, pollen sticking to fur or feathers while feeding on nectar or fruit).
- Highlight that even if these animals do not currently pollinate plants inside the zoo, they **play an essential role in natural ecosystems** and depend on flowering plants for food.

This short reflection helps children understand that pollination is not an abstract concept, but a **real ecological process linked to animals they can see and recognize**, making the learning experience more concrete and memorable.

WATCHING POLLINATORS AT WORK

Target: Early childhood/Primary school

Pollinator monitoring activities for school gardens or zoo visits

This section focuses on pollinator monitoring activities that can be carried out in any green area with flowers and plants, such as school gardens, public parks or green spaces within zoos.
Detailed instructions on how to carry out pollinator monitoring are provided in Section 4 of the Toolkit. Here, the emphasis is on key aspects to consider when working with primary school children or preschool groups, to ensure safety, engagement and meaningful observation.

Notes for educators: key points to consider with young children

- **Prepare children before going outdoors**
  - Before entering the garden or green area, it is important to explain how to move safely and how to behave around insects that may sting.
  - Children should be reassured that bees are generally not interested in people when flowers are in bloom.
  - Keeping a respectful distance, speaking quietly and not disturbing insects helps everyone stay safe and allows better observation.

- **Change familiar behaviours in familiar spaces**
  - If the monitoring area is a space that children already know (such as the school garden), they may instinctively run and play.
  - Remind them that this is a special observation activity, and that they need to move slowly and carefully, as if they were in a museum.
  - Moving calmly allows children to explore the space without frightening insects away.

- **Start with group observation**
  - At the beginning, it is recommended to observe together as a whole group.
  - One effective approach is to stand in a semi-circle around a flowering shrub or a flower-rich patch of grass and observe quietly to see if any insects appear. This method usually ensures that everyone sees something.

    This moment can also be used to:

  - show children different types of flowers
  - observe them using magnifying glasses or a portable stereomicroscope.

- Particularly favourable conditions occur when observing a fruit tree, which can be monitored weekly from flowering to fruit production, allowing children to follow the entire transformation process.

- Insects should be photographed whenever possible and later identified, linking the activity to the recognition and classification work previously done in the classroom.

- Only with older children is it advisable to work in small, semi-autonomous groups, which must always remain supervised.
  Each group can use identification sheets to record insect observations in real time.
  Educators should take as many photos as possible.

- Not recognising an insect on the spot is completely normal. Thanks to photographs, it is often possible to identify the species later. Images can be uploaded to **iNaturalist** as part of the **Zoo Life Pollinators** project.

Back in the classroom: reviewing and reworking the collected data

Target: Early childhood/Primary school

Once back in the classroom, it is important to give children time to revisit what they observed outdoors and transform their observations into a shared learning experience.
At this stage, the goal is scientific accuracy, but also making sense of the experience, reinforcing key concepts and valuing each child's contribution.

Activity procedure:

1. Collecting and revisiting observations together

Start with a **group discussion**, supported by:

- photos taken during the monitoring activity
- simple notes made outdoors.

Educators can ask questions such as:

- *What did we see on the flowers?*
- *Did we all see the same insects?*
- *Which insects appeared more often?*

2. Creating a "Pollinator Collection" (trading cards activity)

One effective way to rework the collected data is to create a **pollinator trading card album**.

- Educators provide a set of PDF cards featuring the most common pollinators observed during monitoring activities.
- Children (or teachers) choose which cards they want to print, based on insects they observed.
- The cards can be:
    - glued into a personal album
    - or assembled together on a large class poster.

Each card can include:

- the insect's name (common name is sufficient)
- space for children to add:
    - a drawing
    - a short note (*"I saw it on the yellow flowers"*, *"It was very fast"*).

This activity transforms observations into a tangible collection, reinforcing recognition and memory.

3. Sorting and grouping the cards

Once the cards are collected, children can be invited to:

- group insects by type (bees, flies, butterflies, beetles)
- separate pollinators and non-pollinators
- sort them by:
  - size
  - number of times they were observed.

This introduces early classification and data organisation skills in a playful way.

4. Reflecting on the experience

To conclude, encourage children to reflect on:

- *What was the most surprising insect or thing you saw today?*
- *Which insect would you like to learn more about?*
- *What could you do at home or at school to help pollinators?*

This version keeps the focus on curiosity, exploration, and taking action, connecting observation to care for nature.

Every observation you make supports local biodiversity and helps our pollinators thrive. Record what you see today, your contribution makes a difference!

POLLINATOR ESCAPE ROOM

Solve the challenges. Help pollinators survive.

Target: Primary school

Station 1: Lack of Food

Problem description:
"Pollinators are hungry! There are not enough flowers in the garden, so bees, butterflies and other pollinators don't have enough nectar and pollen to eat."

Mission:
Help the pollinators by solving the mystery in this station.

Instructions for children:

1. Your teachers have hidden three objects somewhere in the garden.
2. Work together with your group to find all three items.
3. Once you have collected the three objects, think carefully:
   - *How could these objects help pollinators?*
4. When your group figures it out, share the solution out loud.

Tips for teachers:

- The activity works best with 4 groups in the garden, each at a different station.
- The things you have to hide are: a trowel, a flower seedling or small plant, soil.
- You can give some clues or let the children look for them themselves.
- Encourage children to explore, observe carefully, and discuss among themselves to figure out the solution.
- This is a chance to let them come to the solution on their own, linking observation, reasoning, and action.
- The solution is: Plant more flowers! You can do this thing after, with all of children, as a group work.

Station 2: Lack of Shelter

Problem description:
"Pollinators need a safe place to rest and lay their eggs, but many insects and small animals don't have anywhere to hide or build their nests."

Mission:
Help the pollinators by discovering how to use the materials on your table.

Instructions for children:

1. On your table, you will find different materials: empty cans, straws, reeds, bamboo sticks, pinecones, bark, and string.
2. Work together with your group to figure out what to do with these materials and how they might help pollinators.
3. Think carefully and discuss:
    - *How could these materials be combined to build something useful?*
    - *How can insects use them?*
4. Answer to your teacher so your group will discover the solution.
5. After completing the activity, carefully dismantle the materials so the next group can try the challenge.

Tips for teachers:

- Support the children's reasoning without giving away the solution immediately.
- SOLUTION: Each can is filled with a single material and then hung using the string. These become nests and shelters that different types of pollinators can use.
- Encourage them to experiment with combinations and discuss possibilities.
- Highlight the importance of providing shelter for pollinators in gardens and green spaces.
- Remind children that different materials attract different pollinator species.

Station 3: Pesticides

Problem description:
"Some areas of the garden have chemicals that can harm pollinators. Bees, butterflies, and other insects need safe spaces to feed and live."

Mission:
Help the pollinators by figuring out which actions are safe for them, and which are harmful.

Materials / Setup:

- Prepare cards or images showing different gardening actions.
- Some cards show dangerous actions for pollinators (using herbicides and pesticides, planting only one type of flower or piant, creating a perfectly manicured lawn), others safe actions (garden with lots of different flowers, low-mowing areas, bee hotels, water bowls)

Instructions for children:

1. Work in your group to sort the cards into two piles: safe and unsafe for pollinators.
2. Discuss your choices together:
    - *Why is this action safe?*
    - *Why might this action be harmful?*

Tips for teachers:

- Encourage reasoning and discussion; do not tell children which actions are safe at first.
- Highlight how pollinators are affected by chemicals, and how natural solutions help both plants and pollinators.

Station 4: Climate Change & Air Pollution

Problem description:
"Pollinators are facing a new challenge: the weather is changing, and flowers and plants are blooming at different times. This makes it harder for bees, butterflies, and other pollinators to find food. These changes are caused in part by air pollution and human activities."

Mission:
Help pollinators by showing the difference between behaviours that harm the air and those that protect it.

Materials / Setup:

- A large sheet of paper or poster
- Coloured pencils.

Instructions for children:

1. Work together with your group to assigne:
    - Behaviours that harm air quality (e.g., lots of cars, factories emitting smoke, littering)
    - Behaviours that protect air quality (e.g., planting trees and flowers, riding bikes, using public transport)
2. Discuss together:
    - *Which actions make it harder for pollinators to survive?*
    - *Which actions help pollinators and nature?*

Tips for teachers:

- Encourage discussion about cause and effect: how human behaviour affects the environment and pollinators.
- Highlight that even small actions, like planting flowers or using less car transport, can help pollinators.

Conclusion & Reflection

At the end of the escape room, gather all the groups together and review what everyone has discovered and created. Discuss:

- the solutions for each pollinator problem (planting more flowers, providing shelters, avoiding pesticides, protecting the air),
- the materials and actions used at each station,
- and what surprised them the most during the activities.

If possible, consider creating a small garden area with some flowers and bee hotels as a lasting reminder of what the children learned.

For more details about realizing a pollinator friendly area look at section 4 of the Toolkit.

Finally, together with the children, make a list of “good practices” to help protect pollinators, plants, and clean air. This reflection reinforces the connection between observation, action, and caring for biodiversity, and encourages children to adopt behaviours that benefit both nature and people.

LEARNING TO CODE WITH POLLINATORS

Guiding pollinators through goals and obstacles

Target: Primary school

In these activities, children explore basic coding concepts while guiding pollinators through an environment made of goals and obstacles.

Group setup

- Children work in groups of 5.
- Each child has one pollinator robot or token, representing a different insect (bee, ladybird, butterfly, beetle, fly, moth).

Tiles and board elements

Educators prepare **cards or tiles** to be placed on the board or grid.

Goals include:

- 5 different types of flowers
- water
- 5 different types of shelters (bee hotels, hollow stems, natural refuges).

Obstacles include:

- asphalt
- hail
- pesticides
- drought
- air pollution
- floods.

For more details about the threat of pollinators, look at section 3 of the Toolkit.

The number of tiles used can be adjusted according to the size of the board and the desired difficulty level.

Coding levels

The same setup can be used at different levels of complexity.

Level 1 – Free choice (introductory)

- Each pollinator can move towards any flower or shelter.
- The focus is on:

- sequencing commands
- understanding directions
- reaching a goal while avoiding obstacles.

Level 2 – Matching challenge (advanced)

- Pollinators must reach the flower that matches their traits.
- Flower and pollinator characteristics are matched to introduce coevolution concepts (see Section 2 for details).
- Children must plan their route more carefully and may need to revise and debug their sequence.

For the activities:

- arrow cards are used to plan movements
- children place arrows on the board or ground before moving their pollinator
- movements are executed step by step, encouraging discussion and correction.

This version is particularly suitable when using:

- floor grids marked with tape
- cardboard boards
- synthetic grass mats.

Educational focus

- logical thinking and problem-solving
- collaboration within small groups
- awareness of pollinator needs and environmental threats
- early understanding of human impact on ecosystems.

6.4 Secondary school

FROM OBSERVATION TO CLASSIFICATION

Materials

- Insect cards or images (without non-insect intruders)
- Printed images from reliable online sources or
- Sets of 3D insect models
- Four boxes or areas labelled:
  Bees – Butterflies & Moths – Beetles – Flies
- Optional: simplified dichotomous key handout or poster.

Objectives

- Use simplified dichotomous keys to classify major groups of pollinating insects.
- Develop analytical observation and decision-making skills.
- Understand the limits of simplified classification tools.
- Recognise morphological diversity within pollinator groups.
- Introduce the concept of biological classification as a hypothesis-based process.

Content Overview (Teacher Notes)

Focus groups of pollinating insects:

- Butterflies & moths (Lepidoptera)
- Bees (Hymenoptera)
- Flies (Diptera)
- Beetles (Coleoptera)

Key identification traits (working hypotheses)_read section 2 of the Toolkit:

- Butterflies & moths: wings covered with scales; never entirely transparent
- Beetles: hardened forewings (elytra) protecting folded wings
- Flies: one pair of wings (2 total); often transparent
- Bees: two pairs of wings (4 total); body often hairy and patterned

Emphasise that these are useful but simplified rules, not absolute truths.

Activity procedure:

1. Introduction

Briefly discuss the role of pollinators and clarify that classification is a tool scientists use to organise biodiversity. Introduce the idea of dichotomous keys as step-by-step decision tools based on observable traits (It is also possible to have them create simplified dichotomous keys at this link https://it.venngage.com/templates/diagrams/dichotomous-key).

2. Review of key traits

Present each insect group using images or models and ask students to identify distinguishing features and explain why those traits are useful for classification.

Encourage students to compare similar-looking insects (e.g. bee vs hoverfly).

3. Classification task

Students work individually or in small groups.

- Each group receives a set of insect images or models.
- Students classify each insect using the provided traits or a simplified dichotomous key.
- For each decision, students should be able to explain which feature guided their choice.

Optional: ask students to note insects that are difficult or ambiguous to classify.

4. Discussion and reflection

Guide a short discussion with questions such as:

- *Which insects were easiest to classify? Why?*
- *Which was more challenging?*
- *Which traits were most reliable?*
- *What are the limits of using only a few visible features?*

Highlight that scientific classification involves revision, uncertainty, and refinement.

Extensions (especially suitable for upper secondary)

- Bees vs wasps: ecological roles, body hair, feeding behaviour
- Hoverflies: mimicry as an evolutionary strategy
- Butterflies vs moths: antennae, circadian activity, resting posture
- Link to evolution: why different insect groups evolved different traits

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- Connection to pollination efficiency: which traits make insects better pollinators?

AM I A POLLINATOR OR NOT?

Students are presented with a set of animal cards. For each card, they are asked to decide whether the animal shown can act as a pollinator, and to justify their choice.

The cards include:

- **Insect pollinators** (bees, bumblebees, butterflies, hoverflies, beetles)
- **Non-pollinating insects**, often carnivorous or predatory species that do not interact with flowers
- **Birds and mammals**, some of which are pollinators (e.g. bats, hummingbirds or other nectar-feeding birds), others not
- Optionally, **reptiles or unusual species**, to stimulate deeper discussion and challenge assumptions.

How the activity works

Students work individually or in small groups and, for each card, are asked to:

- decide whether the animal is a pollinator or not
- explain their reasoning using ecological or behavioural clues.

Guiding questions may include:

- *Does this species visit flowers regularly?*
- *What is its main diet?*
- *Could pollen be transported on its body, fur or feathers?*
- *Is pollination intentional or incidental?*

Focus of the discussion

- For **insects**, students can reason in terms of:
    - feeding strategy (nectar, pollen, predation)
    - morphology (hairy body, mouthparts)
    - frequency of flower visitation.

- For **birds, mammals and other vertebrates**, the discussion can move towards:
    - incidental vs specialised pollination
    - coevolutionary relationships
    - ecological context (habitat, plant species involved).

Disagreements or uncertainty are part of the learning process and should be encouraged as a basis for discussion.

Educational aims

The purpose of this activity is not simply to test knowledge, but to:

- challenge simplified ideas of what a pollinator is
- highlight that pollination is a functional role, not a taxonomic category
- show that pollination involves a wide range of species, including zoo animals that students may already know
- stimulate critical thinking and argumentation based on evidence.

In this way, surprise and debate become powerful educational tools, helping students develop a more nuanced understanding of biodiversity and ecological interactions, while preparing them for more complex activities on pollination, conservation and ecosystem services.

POLLINATION STRATEGIES

Target: Lower secondary / Upper secondary school

Duration: 30–45 minutes

Materials:

- 3D flower model (commercial or handmade)
- Proportionate model of a pollinating insect (3D plastic model preferred; plush or DIY acceptable for demonstration)
- Optional: diagrams of flower anatomy, microscope images, or slides.

Objectives:

- Review and consolidate flower and insect anatomy.
- Understand pollination as a functional biological process, not only a sequence to memorise.
- Analyse the mutualistic relationship between plants and pollinators.
- Understand the link between pollination, fertilisation, and fruit/seed development.
- Develop scientific reasoning through guided questioning and hypothesis testing.

Activity Procedure:

1. Revisiting structures (flower and insect)

Present the 3D flower model and ask students to recall or identify the main structures:

- petals
- stamens (anthers and filaments)
- pistil (stigma, style, ovary).

Repeat the process with the insect model, focusing on features relevant to pollination:

- body segments
- wings
- sensory organs
- bristles.

Encourage students to name structures and explain their function.

2. The key question: why do insects visit flowers?

Ask students:
"Why do insects visit flowers?"

Guide the discussion toward feeding behaviour and nectar as an energy source. Emphasise that this motivation is essential to understanding the entire process.

3. Locating the nectar (guided reasoning)

Ask students to hypothesise where nectar is located within the flower. Allow multiple answers without immediately confirming or rejecting them. Then review each proposed position and discuss why it would or would not be functional. Explain that nectar is typically located at the bottom of the flower, protected by petals forming a “bowl”.

If students raise objections (e.g. “flowers aren’t waterproof”), use analogy and reasoning: small quantities of liquid can be retained even without impermeable structures.

4. Pollination in action

Demonstrate how the insect reaches the nectar by moving the model deep into the flower.
Ask:
“What happens to the insect at this point?”

Explain how pollen grains from the anthers adhere to the insect’s body hairs.
Then ask:
“Why does the insect visit another flower?”

Guide students to recognise that feeding behaviour causes pollen transfer between flowers of the same species.

5. From pollination to reproduction

Explain what happens when pollen reaches the stigma:

- pollen tube formation
- fertilisation of ovules.

Ask students to predict the outcome:
“What does the flower become after fertilisation?”

Conclude by explaining fruit and seed formation and their role in plant reproduction and species survival.

Key concept to emphasise

Pollination is not a random or purposeless action performed by insects. It is a strategy evolved by plants to reproduce successfully, using insects as vectors to transfer pollen between flowers of the same species. All this because plants cannot actively move to look for partners with whom to mix their genetic heritage.

Possible challenges:

- Students may know the terminology but not the functional logic.
- The insect-centred view may overshadow the plant's reproductive strategy.
- Upper secondary students may underestimate the ecological relevance of pollination.

Extensions (especially for upper secondary):

- Coevolution of plants and pollinators (look at section 2 of the Toolkit).
- Consequences of pollinator decline on ecosystems and food systems (look at section 3 of the Toolkit.)
- Flower Dissection and Microscopic Observation.

  Students can carry out a simple anatomical dissection of a flower to observe its main structures directly. Using fresh flowers, students carefully separate and identify the different parts (petals, sepals, stamens and pistil), linking each structure to its function in reproduction. The activity can be further enriched through microscopic observation. In particular, observing pollen grains under a microscope allows students to appreciate their shape, size and diversity, and to better understand their role in fertilisation.

WATCHING POLLINATORS AT WORK

This section presents pollinator monitoring activities suitable for lower and upper secondary school students. Observations can be carried out in any flower-rich environment, such as school gardens, public green areas, natural reserves or zoo green spaces.

Detailed monitoring protocols are provided in **Section 4** of the toolkit and in the handbook.
Here, the focus is on methodological aspects, group management and educational value when working with adolescents, with particular attention to scientific observation, data collection and interpretation. In addition, involving them in citizen science projects and data collection through apps will help them see smartphones in a different way: not just as toys, but as powerful scientific tools.

Notes for educators: key points for secondary school students

Preparing students before fieldwork

Before going outdoors, it is important to briefly review safety rules and appropriate behaviour around insects, especially stinging species.

Students should understand that:

- pollinators are generally not aggressive and are focused on flowers,
- calm movements, respectful distance and quiet voices improve both safety and observation quality,
- the goal is not to interact with insects, but to observe them as objectively as possible.

This moment can also be used to frame the activity as a **field research experience**, rather than a simple outdoor lesson.

Shifting perspective in familiar environments

If the monitoring area is a space student already know (e.g. a school garden), they may initially treat it as a recreational area.

It is useful to explicitly redefine the space as a **study site**, comparable to a natural history field station.
Students should be encouraged to:

- move slowly,
- focus on details,
- observe patterns and behaviours over time.

This change of attitude supports more accurate observations and reduces disturbance to insects.

Initial collective observation

The activity can begin with a short collective observation session.

Students stand around a flowering area (e.g. shrub, meadow patch, flowering tree) and observe quietly for a few minutes, noting:

- which insects arrive first,
- how many individuals appear,
- which flowers are most visited.

This shared moment helps align attention, introduces observation criteria and ensures that all students have a common starting experience.

Individual or small-group monitoring

Secondary school students can work in small, semi-autonomous groups, always under supervision.

Each group can:

- select a specific plant or area to monitor,
- record observations using datasheets or digital tools,
- photograph insects for later identification.

All details relating to monitoring and field sheets can be found in the monitoring handbook.

Photographing and identifying pollinators

Whenever possible, insects should be photographed rather than identified on the spot.

Photographs can later be:

- analysed in class,
- compared with identification keys,
- uploaded to platforms such as **iNaturalist,** within the Zoo Life Pollinators project.

This approach reinforces the idea that scientific identification is often a process, not an immediate answer.

Dealing with uncertainty

Not being able to identify an insect immediately is normal, even for experts. Students should be encouraged to:

- accept uncertainty,
- formulate hypotheses,
- use additional resources to refine identification later.

This helps shift the focus from “right or wrong answers” to scientific reasoning and evidence-based conclusions.

For the tips for taking effective insect photographs, read section 4 of the toolkit.

Data elaboration methods

After the monitoring activity, collected data should be organised and analysed to give meaning to the observations. Students can begin by compiling their records into a shared table, grouping observations by plant species, insect group or observation site.

Simple analyses may include:

- counting the number of visits per insect group,
- comparing which flowers attract more pollinators,
- identifying recurring patterns or notable absences.

Photographs can be used to confirm identifications and to refine classifications using guides or digital platforms. At this stage, emphasis should be placed on data interpretation rather than precision: incomplete data, uncertainty and observational limits are part of real scientific work.

The elaboration phase can conclude with a short discussion or written reflection in which students propose explanations for the observed patterns and consider how environmental factors (weather, time of day, plant diversity) may have influenced the results.

7. Municipalities

Municipalities and local administrations play a crucial role in pollinator conservation, particularly in urban and peri-urban environments where green spaces are actively managed and human activities strongly influence biodiversity.

This section is dedicated to public institutions and local authorities committed to improving the management of public green areas with the aim of supporting pollinators and enhancing ecosystem services. Cities, towns, and peri-urban areas host a wide range of potential habitats - parks, gardens, road verges, schoolyards, roundabouts, and vacant lots - which, if properly managed, can significantly contribute to pollinator survival and connectivity.

These are just some suggestions that will be explored further by the end of the project and will lead to the definition of the best practices.

7.1 Legislative framework

At European level, pollinator conservation is supported by a growing policy framework that provides guidance and opportunities for action at local and municipal scale.

The **EU Pollinators Initiative** sets the overall strategic vision, aiming to reverse the decline of wild pollinators by improving habitats, addressing pressures such as pesticide use and land management, and strengthening knowledge and public awareness. Although not legally binding, the initiative offers a clear reference framework that municipalities can use to align local green management practices with European biodiversity objectives.

Official reference:
https://www.bc-europe.eu/webpage.php?name=eu-pollinator-initiative

https://www.eurosite.org/wp-content/uploads/EU-Pollinators-initiative-Revision-EHF-Final.pdf

More recently, the **Nature Restoration Law** introduces binding targets for restoring degraded ecosystems across the EU, including urban and peri-urban environments. For municipalities, this represents both a responsibility and an opportunity: restoring green spaces, improving habitat quality, and increasing ecological connectivity can directly contribute to compliance with national restoration plans while delivering social and environmental co-benefits for citizens.

Official text and overview:
https://op.europa.eu/en/publication-detail/-/publication/ddcb6a5e-ca33-11ea-adf7-01aa75ed71a1/language-en

7.2 Recommended actions for Municipalities

Municipalities play a key role in pollinator conservation through the everyday management of public green spaces. Even small, low-cost adjustments in planning and maintenance routines can significantly improve habitat quality for pollinating insects in urban and peri-urban areas, without compromising safety or usability.

7.2.1 Green space management practices

One of the most effective and immediately applicable actions is reducing mowing frequency and introducing staggered mowing schedules.

Operational guidance:

- Limit mowing to 2–3 cuts per year in selected areas instead of regular, uniform mowing.
- Avoid mowing during peak flowering periods (spring and early summer).

Differential mowing strategies can be implemented by dividing green areas into zones with different management objectives:

- High-use areas (playgrounds, sports fields, paths): regular mowing for safety and accessibility.
- Medium-intensity zones (lawns, park margins): reduced mowing frequency.
- Ecological refuge zones (edges, slopes, unused areas): minimal or no mowing during flowering seasons.

Clear signage explaining the purpose of unmown areas helps prevent negative public perception and increases citizen acceptance.

A further priority is the elimination or strong reduction of pesticide use in public green spaces.

Operational alternatives include:

- Mechanical weed control (manual removal, thermal treatments).
- Selection of plant species adapted to local conditions, reducing the need for treatments.
- Preventive measures such as soil improvement and plant diversity to limit pest outbreaks.

7.2.2 Planting strategies

For new plantings and renovation projects, municipalities are encouraged to prioritise native plant species, as these provide more suitable nectar, pollen and habitat resources for local pollinators.

Operational criteria for plant selection:

- Preference for native or regionally adapted species.
- Inclusion of plants with staggered flowering times, ensuring resources from early spring to late autumn.

- Avoidance of ornamental varieties selected only for aesthetic traits and poor nectar production.

Collaboration with local nurseries, seed producers and agricultural enterprises can:

- Facilitate access to appropriate plant material.
- Support local economies.
- Ensure genetic compatibility with local ecosystems.

Municipal guidelines for pollinator-friendly public green design should integrate:

- Structural diversity (flowerbeds, hedgerows, meadows).
- Habitat connectivity between green spaces.
- Long-term maintenance planning, not only initial planting.

7.2.3 Pollinator-friendly flowerbeds and gardens

Pollinator-friendly flowerbeds and gardens can function as demonstration sites, combining ecological value with educational and aesthetic roles.

Key operational elements include:

- **Soil assessment** prior to planting (texture, compaction, drainage).
- Use of **natural mulches** (wood chips, straw, gravel) to retain moisture and limit weeds, avoiding plastic sheets.
- **Efficient irrigation systems**, especially during establishment phases, with reduced watering once plants are established.
- Careful consideration of **sun exposure**, as most nectar-rich plants require full sun.