Sexual reproduction of plants

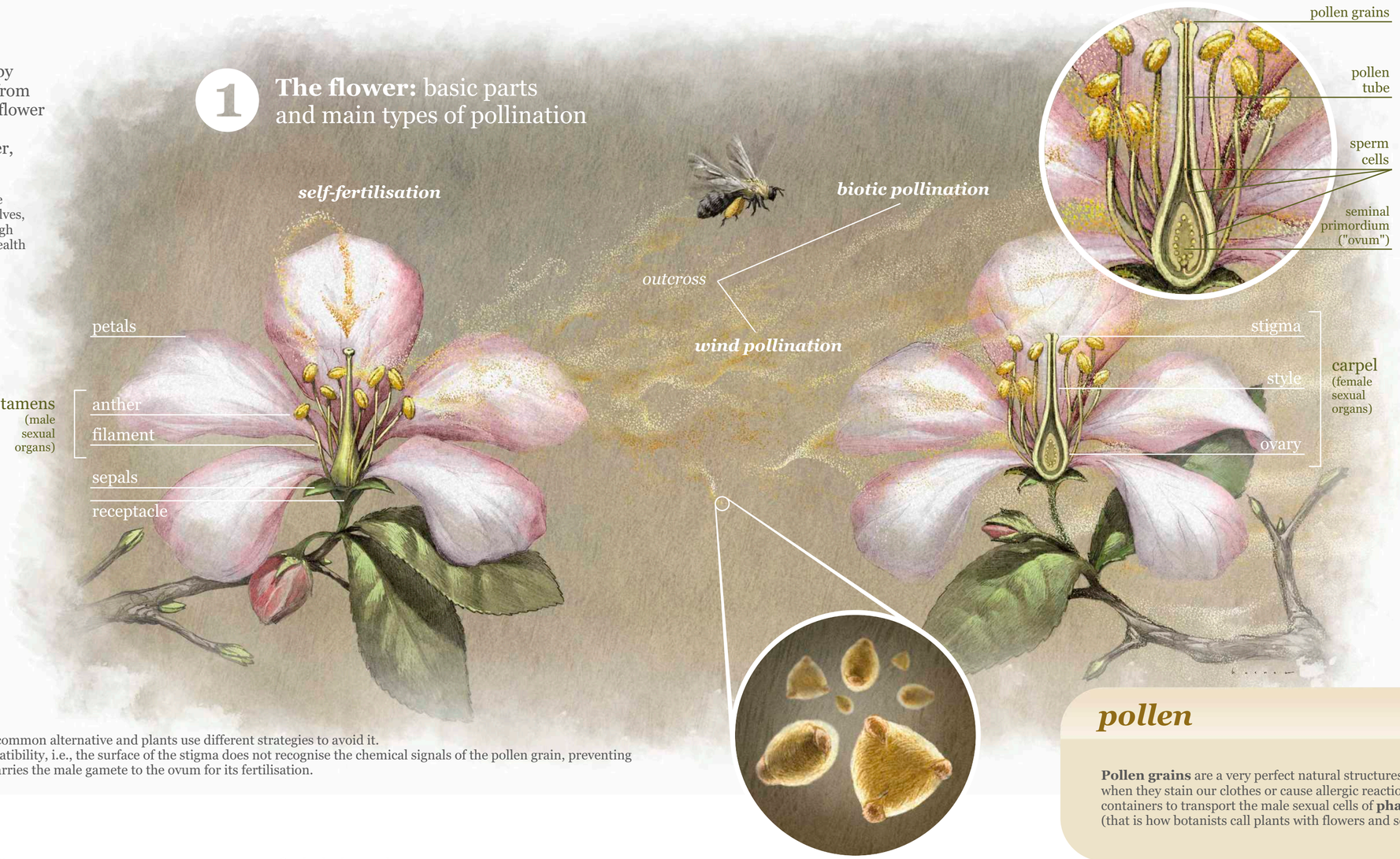
Pollination is the process by which pollen is transferred from the anthers (male part) of a flower to the stigma (female part) of the same or another flower, mainly of the same species.

Although most plants can reproduce asexually, creating clones of themselves, the genetic exchange attained through **outcrossing** is vital for the good health of the population in the short run and for the evolution of species in the long term.

There are three vectors or agents responsible for carrying pollen from flower to flower: **wind**, **water** and **animals** (the later being called ***biotic pollination***).

Many **plants** are **anemophylous**, i.e., they are wind pollinated; some examples are oak, beech, birch, grass or most of conifers (such as pine, fir and cypress).

1 The flower: basic parts and main types of pollination



Self-fertilisation is not the most common alternative and plants use different strategies to avoid it. Often there are cases of self-incompatibility, i.e., the surface of the stigma does not recognise the chemical signals of the pollen grain, preventing the growth of the pollen tube that carries the male gamete to the ovum for its fertilisation.

it is said that a plant species is ...

DIOECIOUS (separated sexes), when there are individuals with male flowers and individuals with female flowers. Example: Holly.

MONOECIOUS, when male and female flowers are separated but coexist within the same plant. Example: Hazel

HERMAPHRODITE, when stamens and carpels are found within the same flower, which is the case of approximately 80% of the flowering plants.

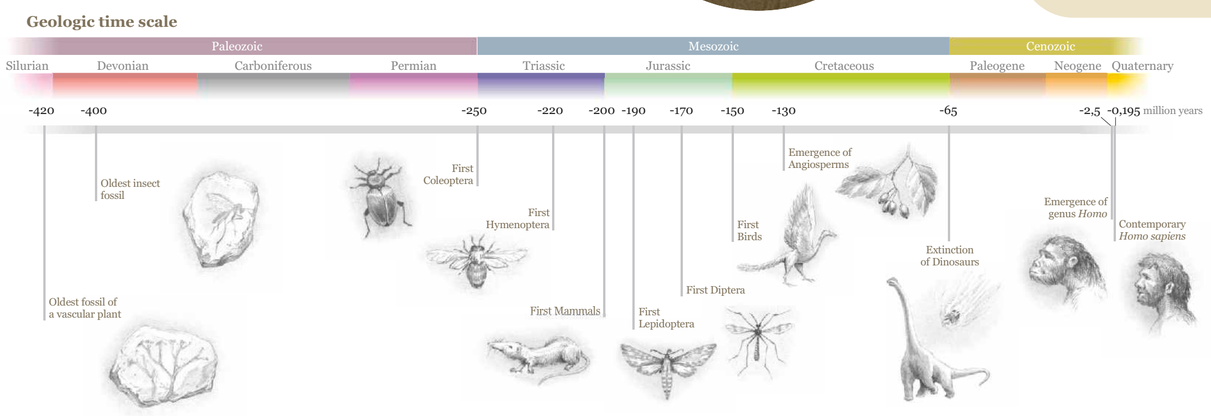
pollen

Pollen grains are a very perfect natural structures. Most of us are only conscious of their existence when they stain our clothes or cause allergic reactions, but they are extremely-well-prepared containers to transport the male sexual cells of **phanerogams** or **spermatophytes** (that is how botanists call plants with flowers and seeds).

2 Biotic pollination

Insects are by far the largest group, although some **reptiles**, **birds** and even **mammals** (such as bats and lemurs) may also undertake this important task.

Plants and pollinators have been evolving together for millions of years and probably make the finest example of **mutualism** that can be observed in nature (two species have a mutualistic relationship when both are benefited from that interaction); usually pollinators get a reward from plants, either as food (mainly nectar and pollen), as fragrances that they use later in their courtship or just as protection for their descendants, helping the perpetuation of plants in return.



Angiosperms (flowering plants whose seeds are protected inside a fruit) are by far the largest group of contemporary vascular plants; they are also the plant species that rely more heavily on animal pollination; in fact it is thought that these interactions among plants and insects were, at least in part, responsible for the great diversification of both groups.

*If it were possible to compress all Earth history in one hour, the flowering plants would have only existed in the last minute and a half, whereas humans beings, current dwellers of almost every corner of the planet, would have been born in the **last second**!*

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Pollination and biodiversity

Genes, **populations**, **species** and **ecosystems**; the combination of these elements (each one of them being included within the next, as Russian dolls) constitute what is commonly known as **biodiversity**, the diversity of life forms that populate the Earth.

Tropinota (*Tropinota squalida*) on Rockrose (*Cistus albidus*)
photo: Jesús Manuel Crespo Martín

Common yellow swallowtail (*Papilio machaon*) on Wild carrot (*Daucus carota*)
photo: Ángel Martín Montoya

Long-horned bee (*Eucera longicornis*) on Butterfly orchid (*Orchis papilionacea*)
photo: Francisco Rodríguez Luque

Honey bee (*Apis mellifera*)
photo: David Martín Albaladejo

Hoverfly (*Episyrphus balteatus*) on Rockrose (*Cistus albidus*)
foto: Manuel Ángel Rosado

Heliotaurus ruficollis on California poppy (*Eschscholzia californica*)
photo: Víctor Ángel Suárez Álvarez

Bumblebee (*Bombus terrestris*) on Sunflower (*Helianthus annuus*)
photo: Marta Ramírez Cores

Hummingbird Hawk-moth (*Macroglossum stellatarum*) on Lavander (*Lavandula* sp.)
photo: David Gómez Collado

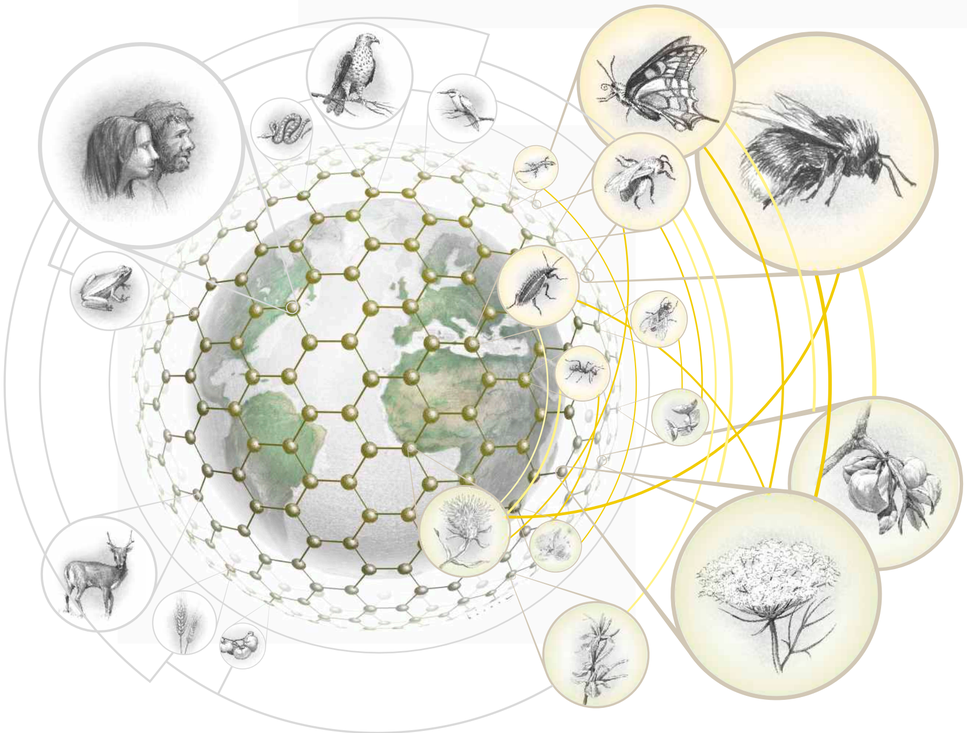
Canary Islands Chiffchaff (*Phylloscopus canariensis*) on Canary Islands Figwort (*Scrophularia calliantha*)
photo: José Juan Hernández Martínez

No species lives isolated in nature; we are all related through a **complex network**, where **plants** and **pollinators** play a key role in both the **functioning** of **terrestrial ecosystems** and the conservation of **biodiversity**. **Without pollinators** many flowering plants do not produce seeds nor fruits, many animals have no food and **the trophic chain is broken**.

As the hexagonal geometry makes it easier for honey bees to optimally use the space, or provides great stability to certain chemical compounds, so does **biodiversity** confer functional **stability to ecosystems**; therein lies the **resilience of ecosystems** after a **perturbation**, being it natural or man made.

Animals, specially insects, play an important role in plant reproduction as they assist in the pollination of many plants species. However, if a nature manager would ask a scientist "**how flowering plants are pollinated by animals?**", a honest scientist would accept "**we do not know**".

There are currently about **352,000 described angiosperm** species and we do not know the **pollination** details of most of them. Nevertheless, it is estimated that about **308,000** (87.5%) of these flowering plants **depend** to a certain extent, **on animals to successfully carry out this process.**



pollination and agriculture

In 2012 we are already **7 billion human beings** living on planet Earth, this population is expected to reach 9.3 billion people by 2050. But... **who will pollinate all the crops that will be necessary to meet the needs of so many people?**

Not all cultivated plant species depend on pollinators for their production. Many **cereals** are wind pollinated; other crops, such as **potatoes**, depend on the vegetative growth of their tubers and, in some cases, as **bananas** and **figs**, pollination is not even necessary.

However, **most cultivated plant species show an increase in seed and fruit production when pollinator animals are present.**

Fruit trees (almond, peach tree, cherry tree, plum, apple tree, pear, etc), **forage legumes** (such as alfalfa or clover), **Cucurbitaceae** (melons, cucumber, pumpkins, courgette, etc), plants for **oil extraction** (such as rape and sunflower) or **textile fibres** (such as linen and cotton) are some examples of plants that could struggle from the lack of pollinators.

The fruit set and fruit quality significantly improve in the presence of **suitable pollinators**, thus it would be wrong to quantify the **benefits** that pollinators pose to crops in absolute terms of production.

APOLO observatory of pollination agents

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Endangered pollinators?

There are several plausible **causes** that could explain a **possible decline on** both wild and domestic **pollinators**.
Most of these drivers affect biodiversity in general and, more specifically, the abundance and diversity of pollinators.
Although they have been studied in isolation, they rarely act separately in nature.

land use changes

Human beings are the species that most greatly disturb their surrounding environment. Consequences of many of our activities are usually **habitat loss or habitat fragmentation**, which unevenly affect across the pollinator taxa. In many cases, **this involves negative effects on their populations** (nesting areas are reduced, food sources eliminated, and so on) although there are certain species that can benefit by being close to us.

introduction of exotic species

The introduction (by humans) of alien plant and animals may cause serious disruption in ecosystems. Competing for space, resources or even pollinators (in the case of plants) may lead to the disappearance of native fauna and flora. To this we must add the problems caused by the **proliferation of pathogens**, often related to the introduction of alien species.

chemicals

Probably the greatest threat to pollinators. Currently, human beings make use of many lab synthesised chemicals for many different purposes. **Most of these chemical substances do not appear in nature** and in many cases **their effects are unknown**. Even in cases where their effects have been studied, **we know the effect of each substance in isolation but not the interaction between the used chemicals**, something much more difficult to predict and that can have very serious consequences.

global environmental change

Scientific data indicate that global **warming** is real and there are evidences pointing to **our activities helping to accelerate the process**. It has been found that the temperature increase may cause many species to **reproduce earlier in the season**, but... **what would happen if the life cycles of plants and pollinators fail to adjust?**

genetically modified crops

Genetically modifying plants in a laboratory trying to get a particular feature, such as higher production, resistance to certain pathogens, etc, is becoming an increasingly common practice. But... **what effects do those artificial transgenic products have on pollinators?**

what can we do?

We could start by:

- **Being aware of the important role pollinators play in nature, appreciate and respect them.**
- **Reducing the use of chemicals**, limiting their use to cases when they are absolutely necessary and selecting environmentally friendly products.
- **Respecting the natural distribution of species**, both plants and animals, avoiding introductions of aliens into ecosystems.
- **Using native plant species** in parks and gardens, hedges, ecosystem restoration projects, etc.
- **Promoting research** and other studies into plant pollination.

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