Bee Species

TASK 1

You can refresh your knowledge about honey bees and learn about some native bees here:

The Solitary Bees by Team Candiru: www.youtube.com/watch?v=hGhyZRY2KFc
The Lifecycle of the Honey Bee: www.youtube.com/watch?v=sSk_ev1eZec

TASK 2

Get to know our native bees a bit better by creating fact sheets on the following bees, with the help of the internet:

a) Honey bees,
b) Wild bee species and
c) Bumble bees (Note: bumble bees officially belong to the group of wild bees).

In your fact sheets, explore the following aspects:

// Appearance
// Size (length)
// Food
// Flight radius
// Foraging / nesting habitat
// Life and social organization

Please note: *you do not need to look through each of the sources listed below in detail. Scan them and search for the specific information that is relevant to the fact sheets you are creating.*

When doing this, compare the information provided for each pollinator species in the different sources to find out if they differ. Consider the following: How can you find out which information is correct? Alternatively, how can you present contradictory information in your fact sheets?

TASK 3

EXTENSION TASK:
If you have finished the exercise before the others, please use the time to do an internet search on the "family members" (castes) in a honey bee colony and their duties and note this information down.

You can use the following internet sources for information:

// https://americanbeejournal.com/the-members-of-a-honey-bee-colony/
// http://agritech.tnau.ac.in/farm_enterprises/fe_api_castesofhoneybee.html
// http://edis.ifas.ufl.edu/in1102
// http://beecare.bayer.com/bilder/upload/dynamicContentFull/Publications/Bee_Book-Bees-Small_insects_big_Impactjrc2sqgk.pdf

The Significance of Pollinators for Ecosystems

*Here you can choose between **alternative 1** (this page) and **alternative 2** (next page) with the corresponding tasks:*

TASK 1.1

ALTERNATIVE 1:

INFORMATION TEXT

Pollination, adaptation and biodiversity

During pollination, the pollen of a plant species is transferred from one flower of the same plant species to another. The flower that has been pollinated in this way is now capable of producing seeds.

When the bee flies from flower to flower in its search for pollen and nectar, some pollen is caught in the hairs on its body and may be dislodged when the bee lands on the next flower. While searching for food, honey bees pollinate many plants – regardless of whether the beekeeper keeps them to produce honey or as crop pollinators. Plants can also be pollinated by the wind, water, birds, bats and other species of bee and insects, including beetles, flies and butterflies.

Pollination is the prerequisite for seed formation and many plants also only form fruits if they have been pollinated. Since bees (honey bees and wild bees, including bumble bees) are among the most important pollinators in the wild, a special adaptation has often evolved between them and the plant that they pollinate. To ensure that bees make the right choice from the great variety of flowers on offer, and that they do not look for nectar in a flower that has already been pollinated, plants provide a smart guiding system: in many plant species, flowers that have not been pollinated smell and appear more attractive to bees than those of other flowers. Their senses, thus, guide them automatically to the right flowers. Humans cannot see these signals with the naked eye. Individual honey bees may show “flower constancy”. This means that they preferentially and repeatedly visit and pollinate flowers of the same plant species. This ensures that the pollen reaches the right plant. Similarly, many wild bees rely on one or just a few particular plant species and, therefore, repeatedly visit flowers of the same species.

Whether it is with the help of wind or animal pollinators, many flowering and seed-bearing plants need to be pollinated in order to reproduce sexually. For this reason, during the course of evolution, numerous flowers have adapted their form to perfectly fit to the needs of the bee as their pollinator: to get to the nectar, the bee needs to brush along the stigma and the stamens, where it automatically picks up pollen grains. These are deposited onto the stigma of the next plant through the same process. The flower has now been pollinated. At the same time, the honey bee’s mouthparts are perfectly suited for taking nectar from the flower. Together, the lower jaw and lower lip form a mouth-part called the proboscis. This is extended and with its help, the bee can penetrate into the interior depths of the flower to obtain nectar.

A high diversity of pollinator species favors a high diversity of plant species, and vice versa: this is a mutually-dependent relationship. As such, efficient pollination is needed to maintain biodiversity – which includes species diversity, genetic diversity and the diversity of ecosystems.

The Significance of Pollinators for Ecosystems

TASK 1.1

An ecosystem is a biological community of interacting organisms and the physical environment in which they live. How does this relate to bees and their environment?

a) Using the information text, describe the pollination process and the adaptation of flowers and bees in your own words. When doing so, also describe how the plant benefits from pollinators and vice versa.

b) Create a suitable diagram illustrating this topic.

c) Finally, explain what biodiversity means and why pollination by insects contributes towards the preservation of biodiversity.

TASK 1.2

ALTERNATIVE 2: What is pollination and how does it work?

a) Use the following websites to work out the pollination process, various ways pollination can occur and the adaptations bees and flowers have made.

WWW

// https://byjus.com/biology/what-is-pollination/
// https://bees.techno-science.ca/english/bees/pollination/types-of-pollinators.php
// http://beecare.bayer.com/bilder/upload/dynamicContentFull/Publications/BEEINFOrmed_7_The-Importance-of-Insect-Pollinatorsjlouz8q1.pdf
// https://www.fs.fed.us/wildflowers/pollinators/animals/bees.shtml
// http://www1.biologie.uni-hamburg.de/b-online/ibc99/koning/pollenadapt.html

b) Write a newspaper or technical article with the title

"The co-evolutionary development of flowering plants and bees and the origin of biodiversity", using knowledge gained so far. Use technical terminology in doing this.

Helpful hint: *In doing so, explore the following aspects in more detail: pollination mechanism, fertilization and reproduction (self- and cross-fertilization), different pollinators, various flower species.*

The Significance of Pollinators for Agriculture

INFORMATION TEXT

Bee pollination services

Almost 90 % of flowering plant species worldwide rely, at least partially, on pollen transfer by insects and other animals. These plants form part of ecosystems which, in turn, also offer a variety of other forms of food, habitat and resources. Similarly, around three-quarters of the most important agricultural food crops worldwide are pollinated entirely or partially by insects.

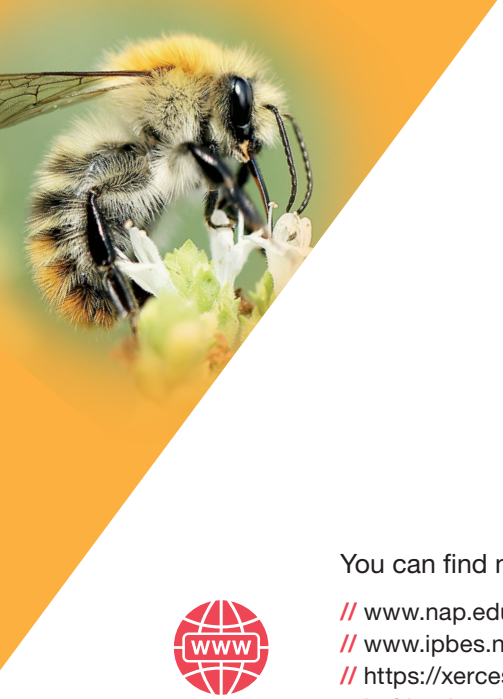
Whereas a few plants rely heavily or exclusively on insect pollination and are dependent on it, others, however, are totally independent of pollinators, including many crops which represent our staple foods (such as maize, wheat, rice and potatoes). In terms of global crop production, the annual tonnage from these staple crops, which are either self-pollinated or wind-pollinated, is significantly higher than that of other crops.

Nevertheless, pollination by insects is a highly valuable service and is also of great significance for modern farming, since many agricultural crops rely on pollination if they are to bear fruit or produce higher yields: for example, strawberry, kiwi fruit or tomato farms throughout the world produce high-quality fruit as a result of insect pollination. Apples, pears and sunflowers also produce considerably higher yields if insects transfer the pollen and farmers don't rely only on the wind to do this. Melon plants or almonds, for instance, are almost exclusively reliant on insect pollination, as a necessary condition for successful cultivation. Without it, they would produce a few, poor-quality fruits or none at all.

Through pollination of fruits, nuts and vegetables, animals such as birds, bats, beetles, butterflies, wild bees and honey bees contribute around five to eight percent of the global crop production (in terms of tonnage) each year. Experts estimate the worldwide economic value of pollination by animals to be US$ 235 to 577 billion annually. Thus, pollinators and agriculture are closely interlinked and the long-term pollination services of the honey bee and other pollinators are of key significance to farmers.

Apart from the honey bee, there are some 550 other wild bee and bumble bee species in Germany, which vary greatly in appearance and size. However, according to the German Wildlife Foundation, half of all wild bee species are regarded as being under threat, as they are unable to find sufficient suitable habitats in many areas. Some of these wild bee species are involved in the pollination of significant crops. This makes it all the more important to protect them.

Sources:
// https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.13012
// https://theconversation.com/
beyond-honey-bees-wild-bees-are-also-key-pollinators-and-some-species-are-disappearing-89214
// http://beecare.bayer.com/bilder/upload/dynamicContentFull/Publications/
20180425_BEEINFOrmed_No6_2018_RZlowjgp61o9h.pdf
// www.ipbes.net/assessment-reports/pollinators
// http://beecare.bayer.com/bilder/upload/dynamicContentFull/Publications/
Bee_Book-Bees-Small_insects_big_Impactjrc2sqgk.pdf



The Significance of Pollinators for Agriculture

You can find more information about the challenges wild bees face at:

// www.nap.edu/read/11761/chapter/5#94
// www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat
// https://xerces.org/2011/08/17/befriend-native-bees-give-them-a-home-wild-bees-pollinate-what-honeybees-cannot/
// http://sciencenordic.com/wild-bees-lose-fight-flowers
// www.sciencedaily.com/releases/2006/10/061025165904.htm

*Here you can choose between **alternative 1** and **alternative 2** with the corresponding tasks:*

TASK 1.1

ALTERNATIVE 1:

Write a newspaper article or a letter to your school's Nature Club or to other fellow students about the role that bees play in:

// species diversity,
// agricultural production,
// consumers.

Helpful hint: *Think about which foods you eat during the day, and where and how they grow.*

TASK 1.2

ALTERNATIVE 2:

Illustrate the role of honey bees and wild bees in agriculture and for humans using a flow chart.

// www.fao.org/pollination/en/
// www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat
// www.fao.org/3/I9527EN/i9527en.PDF

TASK 2

Evaluate the statement

"If the bee disappeared off the surface of the globe, then man would have only four years of life left."

Helpful hint: *Think about plants which rely on pollination by animals, e.g. by looking at:*

// www.fao.org/pollination/pollination-database/en/
// www.researchgate.net/publication/311486448_The_assessment_report_of_the_Intergovernmental_Science-Policy_Platform_on_Biodiversity_and_Ecosystem_Services_on_pollinators_pollination_and_food_production
// https://articles.extension.org/pages/29464/plants-and-animals-partners-in-pollination
// https://beecare.bayer.com/bilder/upload/dynamicContentFull/Publications/BEEINFOrmed_7_The-Importance-of-Insect-Pollinatorsjlouz8q1.pdf

Discussion

Group work:

Today, Europe's ecosystems are shaped largely by humans and their influence on the agricultural landscape.

Hardly any natural, "untouched" landscapes, free from human interference, have existed for centuries and they are not necessarily species-rich.

TASK 1

Discuss the reasons for human influences on ecosystems and to what extent human actions contribute positively to biodiversity.

TASK 2

Think about some practical and meaningful measures that could be taken to protect and preserve honey bees and wild bees, using the knowledge you have gained so far.

After doing this, present your results to the class, so that these can be jointly discussed.

Bee Species

TASK 1

WORKSHEET 1 //// TASK 1

Internet research

There are more than 20,000 different species of bee in the world; most of them are wild bees.

Bumble bees are mentioned separately in this task only. In principle, bumble bees are also classified as wild bees. The text below talks only about honey bees and wild bees.

Please note: *The purpose of this task is to collect basic information, reducing it to the essentials. Approximate values are the aim, allowing students to gain a rough overview.*

Other aspects, such as the kinds of bees in a honey bee colony, are not relevant to the curriculum at this point, but these are mentioned below to provide information for the teacher.

TASK 2

WORKSHEET 1 //// TASK 2

2a) Fact sheet honey bees

	Honey bees
Appearance	// Black and brown to black and orange / yellow, slightly hairy, proboscis, relatively slender body build // All females have a sting
Size (length)	// 10-15 mm
Food	// Pollen and nectar
Flight radius	// Varies according to source, maximum 5-10 km
Foraging / nesting habitat	// Fields, meadows, woodland, wherever they are introduced by humans

Life and structure in a honey bee colony	// Live in colonies (hives), have a queen
	// Complex social structure (colonies containing up to 60,000 bees in the summer, queen and workers overwinter together)
	// **Queen:** main function is to lay eggs (lifespan 1-5 years)
	// **Workers (female):** various duties in the nest: defense, caring for the young, searching for food (lifespan 3-6 weeks in the summer, several months in the winter)
	// **Drones (male):** mating with the queens (lifespan 2-3 months, only in the summer months)
	// Overwintering as a colony

Bee Species

TASK 2

WORKSHEET 1 //// TASK 2

2b) Fact sheet wild bees

	Wild bees*
Appearance	// Varies according to species // In the species occurring in Germany, the females have a sting
Size (length)	// Varies according to species, from 2 mm to 40 mm
Food	// Pollen and nectar // Depending on the species, some specialize on certain plants
Flight radius	// Varies according to species

Foraging / nesting habitat	// Varies according to species and highly specific, for instance woodland areas, semi-dry grassland, river flood plains, pits in sand, gravel or clay, orchards containing a rich variety of plants
	// Nests above ground (in hollow trees, dead wood) or in the ground
	// Around 80 % of wild bee species nest in the ground

Life and social organization	// The species occurring across Europe are mostly solitary (live on their own)
	// Do not generally form colonies
	// No queen
	// Females: egg-laying, collecting food, caring for the young
	// Males: mating (die afterwards)

*** A key outcome of the research on wild bees should be that they are a highly heterogeneous group which can vary greatly in size, foraging and nesting preferences.**

Bee Species

TASK 2

WORKSHEET 1 //// TASK 2

2c) Fact sheet bumble bees

	Bumble bees
Appearance	// Depending on species, black and yellow / often multi-colored, hairy, sturdy body build, rounded rear end, long proboscis // All females have a sting
Size (length)	// 8-40 mm
Food	// Pollen and nectar
Flight radius	// Less than 2 km as a rule, usually considerably less

Foraging / nesting habitat	// Meadows, wasteland, forest edges, hedges, gardens, parks, lowlands to mountains
	// Nests below ground (in mouse holes) or above ground (in hollow trees, nesting boxes for birds)
	// Various nest sizes, but mostly dry, dark hollows

Life and social organization	// Live in colonies, have a queen (colonies containing up to 500 or more bumble bees), but have a less complex social structure (only the queen overwinters) // **Queen:** founds the colony and lays eggs (1 year) // **Workers (female):** duties in the nest, caring for the young, defense and searching for food (4-5 weeks) // **Drones (male):** mating with new queens (die 2-3 weeks after mating)

TASK 3

EXTENSION TASK:

Those students who have finished the exercises before the others, can use the time to do an internet search on the "family members" (castes) in a honey bee colony and their duties and note this information down.

The Significance of Pollinators for Ecosystems

An ecosystem is a biological community of interacting organisms and the physical environment in which they live. In this section, we explore the interaction of bees and plants in their environment.

*Here the students can choose between **alternative 1** and **alternative 2** with the corresponding tasks:*

TASK 1.1

WORKSHEET 2 //// TASK 1 //// ALTERNATIVE 1

1a) and 1b)

// Many flowering plants need to be pollinated in order to reproduce.

// In pollination, pollen is transferred from the male part (stamen, anther) of the flowering plant to the female part (stigma), to allow fertilization and thus the development of seeds to take place.

// Methods: self-pollination, wind pollination, pollination by animals (including insects).

The plant benefits from the pollinators by receiving pollen for successful fertilization, while the pollinators benefit by collecting nectar (a source of carbohydrates) and pollen (a source of protein).

Individual solutions for the diagram; here is one option:

The Significance of Pollinators for Ecosystems

TASK 1.1

WORKSHEET 2 //// TASK 1 //// ALTERNATIVE 1

1c) Biodiversity = biological variety (species diversity, genetic diversity, diversity of ecosystems)

Unwittingly, insects transfer the pollen collected during their search for nectar to other plants of the same species, which they visit as they carry on with their search. This allows the plants to reproduce.

Nearly 90 % of flowering plant species worldwide are at least partially dependent on the transfer of pollen by insects and other animals. These plants have a role to play in the ecosystem as they offer food, habitats and other resources to a large number of other species. For example, an abundance of a wide variety of plant species offers diverse food options for many animal species which, in turn, feed other larger animal species, resulting in a greater diversity of animal species, overall.

The role of pollination by insects in agriculture

100 agricultural crops are responsible for 90 % of the world's foods. 70 of these 100 are pollinated entirely or partly by insects. In total, five to eight percent of global crop yields depend on pollination by insects. The worldwide economic value of pollination by insects is estimated at US$ 235 to 577 billion per year (IPBES Report 2016). This shows that pollination by insects is of great significance for modern agriculture.

But: important staple foods such as wheat, rice and maize are not reliant on pollination by insects. The quantitative share of these staple foods in agricultural production is very much higher than that of many crops which are pollinated by insects (predominantly fruits and vegetables, as well as nuts).

Agricultural crops which are pollinated by bees and other insects

A few agricultural crops are totally reliant on pollination by insects. These include, for example, almonds and melons. Many other foods such as apples, strawberries and sunflowers are dependent on pollination by insects to varying degrees. This can consequently increase the quality and quantity of the yield.

TASK 1.2

WORKSHEET 2 //// TASK 1 //// ALTERNATIVE 2

1a) Pollination (Procedure: see introductory test to Worksheet 2)

There are various forms of pollination:

// Wind pollination
// Pollination by insects

// Cross-pollination
// Self-pollination

In specialist pollinators, the length of the proboscis is adapted to the size and shape of the flowers.

1b) Newspaper article

Students will arrive at their own individual solutions, but should explore the following aspects:

// Pollination mechanism
// Fertilization and reproduction (self- and cross-fertilization)
// Various pollinators
// Various flower species

The Significance of Pollinators for Agriculture

*Here the students can choose between **alternative 1** and **alternative 2** with the corresponding tasks:*

TASK 1.1

TASK 1.2

WORKSHEET 3 //// TASK 1 //// ALTERNATIVE 1 AND 2

Individual solutions

// Plant and pollinator / bee diversity are mutually dependent

// Pollination + high pollinator diversity can positively influence fruit yields, fruit diversity, the good quality of the fruit

// **Farmers:**
- // High yields as a result of pollination
- // Supplying food for the population and high earnings

// **Consumers:**
- // High pollinator diversity and high crop yields (where agricultural crops are dependent on pollination)
- // Assured food supply, wide choice of foods
- // Satisfaction

TASK 2

WORKSHEET 3 //// TASK 2

Evaluation of a statement

The core statement ("If the bee disappeared off the surface of the globe, then man would have only four years of life left.") is not accurate, as not all plants are reliant on pollination by insects: for example, many staple foods which are important to humans, such as rice, maize, cereals and potatoes, do not require insect pollination. In addition to this, there are also various forms of pollination (by the wind, for instance) and other pollinators apart from bees (e.g. other insects such as butterflies or flies).

However, this does not mean that pollinators are not important for human nutrition; their protection is therefore essential.

Further information:

You can find further information on pollinator health in the teaching unit **"Bee health: honey bees and wild bees"**. Using bees as an example, this teaching unit takes into account factors which can have a positive or negative influence on pollinator health, and demonstrates ways in which bee health can be boosted in a targeted way.

You can find further information on the role of pollinators for agricultural crops in the teaching unit **"Modern farming – the needs and challenges"**. In this teaching unit, students learn what is meant by the term conventional agriculture, what significance agriculture has and what the challenges are. It also provides a view of what the agriculture of the future might be like.

Discussion

TASK 1

WORKSHEET 4 //// TASK 1

Individual solutions / individual opinions

Types of and reasons for human interventions:

// Development of towns and villages / Creating more housing for the growing population / Production of goods, food production

// Setting up a worldwide infrastructure / Improved transport links, national and international distribution of goods

// Agricultural use / Increasing yields, feeding the population, guaranteeing low prices

// Redesigning the landscape, types of planting

// Using non-native crop species / introduction or infiltration of foreign species / The natural equilibrium is disrupted

Positive effect on biodiversity:

// Restoration of land areas, to allow animals and plants to resettle

// Planning green and flowering areas

// The continuing development and innovation of the newest technologies allows soils, land areas, etc. to be used more efficiently, thus maintaining habitats for plants and animals

TASK 2

WORKSHEET 4 //// TASK 2

Actions that can be taken to protect and preserve honey bees and wild bees:

Honey bees / wild bees:

// More patches or strips of flowering plants in fields, in private gardens / on private balconies, and also in urban green spaces, to provide sufficient food

// Considered and appropriate use of plant protection products

Honey bees:

// Effective control of pests and diseases, i.e. good beekeeping practice

Wild bees:

// Preserving landscape structures, preventing the destruction of nesting sites and creating nesting habitats, protecting wild plant diversity