SOS Polinizadores

Teacher's & environmental educator's guide

GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES · CSIC · REAL JARDÍN BOTÁNICO · GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES · FECYT · FUNDACIÓN ESPAÑOLA PARA LA CIENCIA Y LA TECNOLOGÍA · HORIZON 2020 · European Commission · BigPicnic

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The pictures contained herein shall be used for teaching purposes only.

Dear teacher or environmental education:

Thank you for reading these few lines, it means you are interested in pollinators. Our objective is that you are eager to pique this same curiosity among your students after reading them.

SOS Polinizadores (SOS Pollinators) is a project aimed at promoting knowledge and study of pollinating insects in their ecosystems among both teachers and students, as well as their effect and impact on our lives and the threats faced by them. To that end, we propose a series of activities integrated in the school curriculum of primary and secondary education, respectively. They can also be implemented by professionals of environmental education in the context of non-formal education.

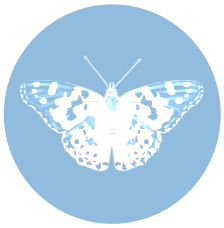
Its methodological basis relies on enquiry-based learning, scientific thinking constituting the backbone thereof. By following this way of working, the students learn to look to nature, to ask themselves and to design ways to answer them, by reasoning and arguing the outcome thereof.

This guide presents two blocks of activities, one for **primary education** and another one for **secondary education**. Each block is divided into a series of activities with continuity, and their contents and objectives are arranged in a learning sequence.

Only through knowledge on the world around us one can raise awareness and generate critical thinking on the environmental problems we face nowadays, in order to make our planet a more welcoming place for all the living beings that inhabit it. **SOS Polinizadores** aims to contribute to that objective.

CONTENTS

1• Why pollinators? Justifying the issues covered



Pollination is a phenomenon whereby pollen grains are transferred from the anthers to the stigma, making sexual reproduction in plants possible and guaranteeing their existence. Therefore, it is an essential **process of the reproduction of angiosperms**. Such transport is often performed by wind and at other times water is the vehicle used to transport pollen. But most plants with flowers need the collaboration of other living beings that transport pollen grains to their destination in exchange for some kind of reward (normally under the form of food). There are no fully accurate data, but some recent studies estimate the 87.5% of angiosperms (approximately 308,000 species) depend on animals to pollinate and produce viable seeds, such proportion being even greater in tropical regions (94%) than in temperate areas (78%) (Ollerton et al. 2011). Furthermore, insects (Klein et al. 2007) pollinate 75% of plant species grown by the human being. Therefore, pollinating agents (mostly insects) play a key role in terrestrial biodiversity. A study published in 2009 estimates that the worldwide economic value of pollinating insects in 2005 amounted to EUR 153 billion, representing 9.5% of the world's agricultural production for human food that year (Gallai et al. 2009).

Numerous threats affecting pollination have been detected in recent years, among which the following stand out: habitat fragmentation, intensive agriculture, diseases (such as that caused by the Varroa mite), abuse of phytosanitary treatments, introduction of alien species and climate change. The findings of these studies alert us to the increasing loss of pollinators and the serious consequences caused by a deficit thereof. Aware of this environmental issue, a number of European countries have promoted the establishment of the ***Coalition of the Willing on Pollinators*** during the ***13th Conference of the Parties to the Convention of Biological Diversity*** held in Mexico City, in December 2017. Spain has recently joined this initiative, aimed at implementing measures and actions for the conservation of pollinators. Nevertheless, when referring to conservation, big cats or whales come to mind but we hardly ever mention insects. For this reason, we believe it is essential to offer educational rules that promote knowledge on pollinating insects. Only through this kind of tools critical thinking on environmental issues can be generated.

2• How to use this guide: general information

2.1. Target audience

This guide addresses both to **science teachers of primary and secondary educations** and environmental educators. It is aimed at **promoting the use of green spaces** to teach science, by promoting the observation of urban biodiversity and natural processes. It also provides educators with **activities, tools and bibliography** to enhance knowledge and study of pollinating insects among their students.

2.2. Requirements prior to the implementation of SOS Polinizadores

Observing pollinating animals requires **nearby green areas** with plenty of plants in flower, such as orchards or parks. It is recommended that this project is implemented in **springtime**. It is important that the teacher or educator has a background in groups of insects. This guide includes vast literature of books, websites, documentaries and educational resources that provide teachers comprehensive information on its contents.

2.3. How is the teaching guide structured

The guide is divided into two parts. Part one contains a description of the project as a whole: the **targets** set and the **methodology** to follow during its development. It also includes a list of **bibliographical resources** to enhance the educator's immersion in the issue that is to be dealt with (as well as a resource to work on with the students).

A **didactic proposal** is then developed. Such proposal is divided into two parts. The activities for the implementation of the project in **primary education** are described in the first part. Its implementation in **secondary education and upper secondary education** is described in the second part.

The cards for each activity include the following information: The first chart emphasises:

- **Timing:** it is the indicative duration. The activity can also be divided into different sessions, if its implementation is thus facilitated.

- **Necessary space**: is the need for space in order for the activity to be implemented.
- **Recommended groups:** it is the recommended number of participants per educator for the correct functioning of the activity.
- **Recommendations:** comments that can improve the activity's implementation.

The specific objectives of each activity are outlined below. The parts in which the activity is divided into are detailed in the following section, together with an itemised timing for each one of them. The activity and each part thereof are then described. In last place, additional information for its implementation is provided (for example, the additional bibliography).

2.4. Useful resources and bibliography for the implementation of SOS Polinizadores

A selection of **teaching materials** is then provided not only to be used to implement the project itself, as an educational resource before carrying out the activities, but it also provides the teacher with in-depth knowledge on the area. It is a selection of audio-visual material, web pages and bibliography that provides valuable information on this issue.

Audio-visual material: support material used in the sessions for consultation

- Beethinking (2017). *How to Keep Solitary Bees*. On: https://www.youtube.com/watch?v=QGEpJ7F_ZuU&t=438s. An introductory video about solitary bees. Duration: 5:18 minutes. Language: English.
- Divulgare (2013). *Breaking the rules*. On: https://vimeo.com/65526941. Video animation about the morphological adaptations of plants and insects for pollination. Duration: 05:55 minutes.
- Divulgare (2013). *Caracterización de la reciprocidad en plantas heterostilas*. On: https://vimeo.com/61299774. Duration: 06:48 minutes. Language: Spanish.
- Divulgare (2013). *Tipos de polinización*. On: https://vimeo.com/68760017. Video about pollination. Duration: 03:54 minutes. Language: Spanish.
- Dunbar, J. y Mann, R. (2015). *The solitary bees*. On: https://www.youtube.com/watch?v=hGhyZRY2KFc. Video about solitary bees Duration: 17:03 minutes. Language: English.
- Makoto, A. (2017). *Story of flowers*. On: https://www.youtube.com/watch?v=vDpFyHmt0AE. Video animation about the plants' lifecycle. Duration: 03:46 minutes.

- Nicholls, S. *Grandes Documentales. Grandes Bichos*. On: https://www.youtube.com/watch?v=e4UG-4BZKYI. Documentary on insects belonging to the "Grandes Documentales" series. Duration: 50:25 minutes. Language: Spanish.

- Nuridsany, C. y Pérennou, M. (1996). *Microcosmos: Le peuple de l'herbe*. On: https://www.youtube.com/watch?v=J9KkzlntuC8. "Microcosmos" documentary about the life of arthropods. Duration: 90 minutes.

- Pérez Hierro, J.C. (2012). *Polinizadores en acción I - En busca de alimento*. On: https://www.youtube.com/watch?v=8QaLKgf1Jvk. Duration: 20:07 minutes. Language: Spanish.

- Varma, A. (2015). *Amazing Time-Lapse: Bees Hatch Before Your Eyes. National Geographic*. On: http://www.thisiscolossal.com/2015/05/an-extraordinary-glimpse-into-the-first-21-days-of-a-bees-life-in-60-seconds/. Development of bees from larvae to adults: Duration: 01:08 minutes. Language: English.

Support material used in the sessions for consultation

- Entomological Society of Spain. On: http://www.entomologica.es/. The society publishes its latest news and entomological studies on this website, focusing on the fauna of the Iberian Peninsula, the Balearic Islands and Macaronesia.

- Asociación Zerynthia. (2016). On: http://www.asociacion-zerynthia.org. A Spanish association for the study, conservation and dissemination of butterflies.

- Bees, Wasps y Ants Recording Society (2016). On: http://www.bwars.com/index.php?q=species_gallery. Web to identify hymenoptera. It is of a scientific nature, but it includes very good pictures of all hymenoptera.

- Bumblebee Conservation Trust (2018). On: https://www.bumblebeeconservation.org/. Website of the English organisation for the conservation of bumblebees.

- Butterfly conservation. On: https://butterfly-conservation.org/. Association for the study, conservation and dissemination of butterflies and months from the United Kingdom.

- Escobes, R. y Vignolo Pena, C. *Los polinizadores más comunes de las zonas vedes de Madrid*. On: https://goo.gl/wvoYks.

- Naya i Díaz, A. *et al*. (2016). *The adventures of nest-making solitary bees*. En: http://blog.creaf.cat/en/coneixement/adventures-nest-making-solitary-bees/?platform=hootsuite. Website on solitary bees and their nests.

- Proyecto Apolo (2010). *Observatorio de agentes polinizadores*. On: http://apolo.entomologica.es/. Website with teaching material for all school groups, combined with very useful technical reports to know more about pollinating insects.

- Travesset, A. (2017). *Pol·linitzadors de les Illes Balears*. On: http://polinib.info/. Website that focuses on pollinators in Mallorca.

- Vignolo Pena, C. (2015). *Bichos de tu entorno: Guía de insectos y otros artrópodos*. On: https://goo.gl/F6N8U8.

General bibliography:

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- Departamento de Ecología UAH (2005). *Métodos de investigación en ecología*: On: http://www3.uah.es/tiscar/Eco_Biol/Complementos_Eco/Cuaderno%20metodos%20investigacion05.pdf

- Ecosistemas. Scientific magazine about dealing with ecology and environment issues. Monograph on pollination. On: https://www.revistaecosistemas.net/index.php/ecosistemas/issue/current

- Gallai, N. y Vaissière, B.E. (2009). *Guidelines for the economic valuation of pollination services at a national scale*. Rome, FAO.

- Harde, K. W. (1984). *Guía de campo de los coleópteros de Europa*. Omega

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- Novak, F. N. Y. F. S. (1984). *Guía de campo de las mariposas de Europa: diurnas y nocturnas*. Omega.

- Ollerton, J., Winfree, R. y Tarrant, S. (2011). "How many flowering plants are pollinated by animals?" *Oikos* 120: 321–326.

- Rivera, I., Melic, A. y Torralba, A. (2015). *Introducción y guía visual de los artrópodos*. IDE@-SEA:2 (1-30).

- Vicente Arranza, J.C. y García Carrillo, A. (2009). *Mariposas diurnas de la Comunidad de Madrid*. Ediciones La Librería.

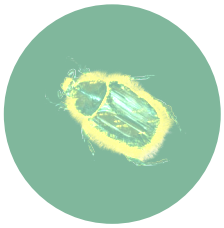
Educational game:

- **Polinizapp**: Educational game designed by the Royal Botanic Gardens in collaboration with the Spanish Foundation for Science and Technology (FECYT, as per its Spanish acronym). Presented as an app and simulated the pollination process of flowers in nature. The player becomes a pollinating insect with two objectives: getting life and score points. The player also faces different threats that should be dodged. Before starting the project in secondary education, the teacher can refer to this resource so that his/her students can download it on their mobile phones and play this game in their free time.

- For **Android**. On: https://goo.gl/cRzmPu

- For **IOS**. On: https://goo.gl/yC26Ez

3• SOS Polinizadores. Overview



3.1. General objectives of the project

The general objectives on implementing this project are:

1. Recognising the importance of insects within the ecosystems, as well as the service rendered by pollination thereto.
2. Stimulating curiosity and motivation to discover our immediate natural environment.
3. Offering tools to facilitate knowledge on pollinating insects in green spaces, thus promoting their identification (Natusfera, Polinizapp…).
4. Promoting learning by harnessing the scientific method.
5. Raising awareness and increasing respect for environmental conservation through reflection and critical thinking.
6. Participating in group activities and behaving in a constructive way, with responsibility and solidarity.

3.2. Some methodological keys to teach science

Some methodological keys that may facilitate the implementation of science teaching projects are included in this section. Some of these keys are:

- **Identifying the level of knowledge** of the students by linking new knowledge to their own.
- Improving learning through **practice and interaction with the environment** to stimulate a **relationship of affection** between them.
- Trying to **motivate students** at all times through participation, experimentation and research.
- Trying to make students understand the **usefulness and functionality** of the contents that are worked on.
- Performing processes of reflection, searching for experiences, communicating and exchanging knowledge aimed at **stimulating critical thinking**.
- Awakening **critical, responsible attitudes** towards our natural environment.

4• Learning activities for primary education students

In order to introduce any of the activities, the teacher can select any of the audio-visual materials listed in section 2.4.

The activities proposed for **children aged between 7 and 11** are the following:

Activity 1.- Pollinating insects around us

Activity 2.- Adaptations of pollinators

Activity 3.- Building an insect hotel

Activity 1.- Pollinating insects around us

Duration (approx.)	Necessary space	Recommended groups	Recommendations
2 h 30 min. It can be performed in 1 or 2 sessions	Classroom, green area	15 persons per educator	Nearby green areas, when the weather is warm preferably

Objectives:

- Becoming aware of the importance of entomofauna (insect fauna) and the pollination process, both for the ecosystems and our everyday life.
- Identifying the major groups of pollinating insects.
- Familiarising with insect identification techniques.

Timing:

- Presentation of the workshop 10 min
- Theoretical presentation: pollination and insects 30 min
- Identification of arthropods around us 45 min

- Field practices of observation of pollinators 60 min
- Sharing of knowledge and closure 5 min

La actividad puede hacerse en una o dos sesiones diferentes consecutivas, si ello facilita su implementación.

Materials and other requirements:

- Insect samples
- Binocular magnifier
- Hand magnifier (at least one per each pair)
- Identification game (Attached) or *Bichos de tu entorno* teaching notebook (free download on: https://goo.gl/Nn1xf7)

Development:

Presentation of the workshop

The contents of the project, the activities, objectives and contents are presented before the activity starts.

Theoretical presentation: pollination and insects

Pollination and pollinating insects are introduced as actors of this process. The particularities of each insects within the animal kingdom are described. To that end, the teacher can use the videos outlined above. Additionally, the website: http://apolo.entomologica.es/index.php?d=materiales, includes lesson plans, as well as educational brochures and triptychs for all educational levels.

Identification of arthropods around us

After gaining some theoretical knowledge, participants then move on to a more manipulative and experimental part of the activity. At the beginning, it is important to analyse the **insect's morphology**, focusing on those features that allow for distinguishing the major groups of arthropods. It is also important to mention the **usage rules of the laboratory material and equipment**.

For this activity, it is advisable to use **samples of those most typical arthropods** of the Iberian Peninsula, notably pollinating insects. Such samples should be individualised and safeguarded, whether using resin or methacrylate boxes to facilitate their observation and ensure enhanced conservation. For more information about **entomological samples**, please refer to the "Additional information" section of activity 1 within activities for secondary education- and upper secondary education students It is suggested to play the game outlined in the "Identifica: Bichos de tu entorno" (picture 1) Schedule or the Bichos de tu entorno (picture 2) guide. The game is adapted to students with a poor literacy level and the guide is adapted to students with a higher level. Both resources are under an "identification key" format, whereby the student has to choose between to options to identify the species.

If binocular magnifiers are available, it is advisable to use them in order to identify certain morphological structures such as mouthparts, the fly's eyes, etc.

Field practices of observation of pollinators

Picture 1

Picture 2

This part of the activity should be performed once the students are familiar with identifying insects. It consists on **observing insects in their natural environment** (picture 3). For those students above 8 years, ***Los polinizadores más comunes de las zonas verdes de Madrid***, available for free download, is recommended (see bibliography). For those students younger than 8, the didactic sheet shown in the "Additional information" section of this same activity is recommended (this sheet is also included in the publication called Los polinizadores más…).

Pollinating insects are more common in green areas with plenty of plants in flower, which are their food. Orchards are very good observation area. Gardens and green areas should have flowering bushes such as Labiates, Leguminoseae or Rosaceae, very frequent in gardening. The best time of the year to observe pollinating insect is between March and June, when the flowers of most plants are more developed.

It should also be noted that the middle of the day -with warmer temperatures- is the best time of the day for observation. Patience is always necessary to look to nature; it always takes time for the human eye to get used to the size and movement of insects.

Picture 3

Sharing of knowledge and closure

After the field practice, it is interesting that students share their knowledge to highlight what they learnt and assess the interest in the activity. Here are some questions for the students:

- Is there great diversity of insects?
- What are the most common insects in our area?
- Do you think they are so common in other times of the year as they are now?
- What were the insects observed by us doing?

Additional information

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Didactic sheet

*** Please mark the pollinating insects identified by you in your nearby green area:**


Gammon's riffle beetle ☐


Museum beetle ☐


Common red soldier beetle ☐


Flower chafer ☐


Hoverfly ☐


Drone flies ☐


Thick-headed fly ☐


Marmelade hoverfly ☐


Mason bee ☐


Western honey bee ☐


Buff-tailed bumblebee ☐


Ivy bee ☐


European orchard bee ☐


Carpenter bee ☐


Great banded furrow bee ☐


Spined yellow -faced bee ☐


Dasyscolia ciliata ☐


Bryony minning-bee ☐


Paper wasp ☐

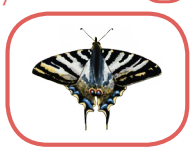

Rhoda nthidiu ☐

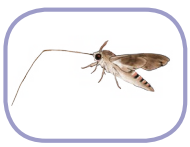

Painted lady ☐


Red admiral ☐


Wall brown ☐


Small white ☐


Southern scarce ☐


Convolvulus hawk-moth ☐


Hummingbird ☐


Dusky clearwing ☐

4.2. Activity 2 Pollination and adaptations of pollinators

Duration (approx.)	Necessary space	Recommended groups	Recommendations
1 h	Open spaces	15 persons per educator	...

Objectives

- Analysing how pollination is performed.
- Understanding the concept of adaptation and coevolution.
- Knowing the major adaptations of insects to pollination.

Timing

- Theoretical chat about major adaptations of insects to pollination — 15 min
- Game "Pollination and adaptations of insects" — 45 min

Materials and other requirements

- Insect masks
- Bottles of different sizes
- Straws of different sizes
- Rubber
- Chalk powder

Development

Theoretical presentation: pollination and adaptations of insects to pollination

The issue that is to be dealt with is explained from a theoretical point of view. Bibliography resources should be used.

Pollination is an "exchange of favours" between the animal and the plant world. Flowers offer their products (pollen and nectar) to insects in exchange for transport part of their pollen to other flowers and help to fertilise their gametes to produce fruit formation. Pollination systems are mainly generalist; in other words, a wide range of insects pollinates the flowers of many plant species, but there are also certain insect species that have adapted their mouthparts to feed on some specific types of flowers. This is because both plants and insects have coevolved for millions of years.

Role-playing game "Pollination and adaptations of insects"

This game consists on "simulating" pollination in different flowers by insects. For this, we need:

- **Insect mask:** it can be easily created searching the Internet for pictures of the insects' faces.
- **Straws of different size and thickness**: to represent the various insects' mouth-parts.
- **Flowers**: they can be created using recycled plastic bottles of different sizes to simulate different types of flowers' corollas. To create the petals, rubber of different colours can be pasted to the stoppers. Yellow chalk powder can be used on the petals to represent pollen (picture 5). The bottle is filled with water or juice, representing nectar.

1. **Part one: how does pollination take place? Exchange of favours between plants and insects…**

In part one, it is explained to the group that flowers have two delicious foods for insects: nectar and pollen. A volunteer pretends to be an "insect" using a mask. The insect approaches the flower and feeds on it by taking nectar using the straw, but it has some pollen (chalk powder) on its face. It then moves to another flower.

Knowledge is shared at the end of the game. The teacher asks what is going on. They all conclude that insects transport pollen from one flower to another as they feed; therefore, the male gametes are being transported enabling pollination. It is important that they see this process as an "exchange of favours between the animal and plant world" (the term "mutualism" can be introduced, if appropriate).

2. Part two: adaptations of insects!

After knowing how pollination takes place, we then move on to the second part of the game, where it is explained that there is a large number of species of pollinating insects and that each one has different mouthparts.

Half of the group pretends to be an insect, using a mask and a straw with different size and thickness. Those insects with short mouthparts have short straws, and those insects with proboscises (such as butterflies) have long, thin straws. The other half of the group pretends to be a flower. In this game, insects approach the flowers to feed on nectar. For this purpose, they insert their "mouthparts" inside the flower's corolla. The "try" each flower they can feed on one by one (picture 4).

The interest is to discover that not all insects can feed on all flowers. Each one of them is "adapted" to a specific type of flower. Insects with proboscises are able to take nectar from those flowers with longer corollas. Insects with shorter mouthpart are not able to take nectar from flowers with long corollas, but they can easily feed on pollen and nectar of those flowers with open corollas.

At the end of the game, it is interesting to **share knowledge**, so that students tell what is going on and draw their own conclusions about the adaptations of pollinating insects and their relationship with flowers.

Picture 4

Picture 5

Here are some questions for the students:

- How is pollen transported? Why is its transport so important?
- What would happen if pollinating insects disappear?
- Do all flowers have the same shape?
- Can all insects feed on all flowers?
- What insects can feed on long-corolla flowers?

Additional information

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4.3. Activity 3 Building an insect hotel

Duration (approx.)	Necessary space	Recommended groups	Recommendations
1h 30 or more based on the hotel's complexity	Open spaces	15 persons per educator	Prepare material in advance

Objectives

- Understanding the importance of humans to preserve the world of nature.
- Learning to build an insect hotel.
- Knowing the biological cycles of pollinating insects and their needs for food and shelter.

Timing

- Discussion about the ecological needs and threats of pollinators 15 min
- Building an insect hotel 75 min

Materials and other requirements

- Several natural materials to build the insect hotel, such as wood, sticks of different thickness, dry grass, rods, trunks, pine cones, bricks, tiles and test tubes.
- Depending on its design, some tools such as saws and drills.

Development

Theoretical presentation: ecological needs and threats of pollinators

Insecticide use against pests in crops and urban areas is one of the main threats to pollinating insects. Additionally, insects hardly have natural areas to nest and winter in our cities. **Insect hotels** are a useful tool to tackle this problem.

In the additional information, teachers have extensive bibliography to prepare a presentation on these contents. Before the presentation starts, they can play some of the videos proposed so that students have their first contact with this issue. A debate on the ecological needs of insects and their threats can then be started, by asking questions such as:

What do you think are the threats to insects in our cities? What about the countryside?

Building an insect hotel

Insect hotels are drawer- or shelf-alike structures where natural elements can be kept inside (sticks, rods, trunks...) to help insects find shelter to make nests and winter (pictures 6 and 7). But above all else, it is a teaching resource to attract people to the incredible world of insects.

There are plenty of types and models of insect hotels. Simple hotels can be built using recycled materials such as recycled plastic bottles and shredded paper and cardboard, while more sophisticated hotels can be built using large wooden structures divided into compartments. You can find examples of these in the "Additional information" section of this activity. Each type of insect fills a different niche and seeks shelter in different structures and materials. For this reason, the more different materials and structures are used, the greater diversity of pollinators will be.

Besides the design, a series of factors should be taken into account when building an insect hotel. In this sense, a few bibliographic notices included in the Additional information section have been selected. A brief summary of some of these issues is presented below:

- **Location**: the ideal location should be protected from wind, south or south-west facing and 10 or 15 cm above the ground. It should also have plants with flowers that serve as food for insects. If there is none, we can plant some of them as we build the hotel.

- **Hotel structure**: a very simple hotel with one only compartment can be designed (for example, reusing a bottle of plastic and inserting rods or straws inside) or otherwise a hotel with more compartments can be built. In this sense, a series of natural elements can be used, such as hollows trees, rods, sticks or pine cones to give shelter to different species, as each species have specific requirements to nest. For example, the violet carpenter bee (*Xylocopa violacea*) needs trunks of 22 cm diameter or greater to nest. It digs tunnels where it deposits her eggs and winters inside the trunks using

its jaws. Some species of the *Osmia* genus build their nests in hollows as narrow as a bamboo cane.

- **Material selection**: natural materials such as wood, sticks of different thickness, stones, straws, rods, trunks or pine cones should preferably be used. If recycled materials are selected, they should be chemical-free and should not have any varnish, paint or glue conglomerate. Bricks and tiles can be used too. Using glass test tubes can be very instructive, so that the various cells built by solitary bees can be observed.

Picture 6

Picture 7

Insect hotel build for the Royal Botanic Gardens.

Additional information

Models of hotels for insects:

Bibliography and websites about building hotels for insects:

- Aguado, L.O., Fereres, A. y Viñuela, E. (2015). *Guía de campo de los polinizadores de España*. Mundiprensa.

- Eco Sapien. (2016). *Eco How: How to make a bee home*. On: https://www.youtube.com/watch?v=3zaQzJxSheQ. Audio-visual material about how to build an insect hotel at no cost using very simple elements. Duration: 02:29 minutes. Language: English.

- Nadreau, J. *Cómo hacer un Hotel de Insectos*. On: http://www.eugolearning.org/sites/default/files/files/documents/insect_house_es.pdf

- Naya i Díaz, A. *et al*. (2016). *The adventures of nest-making solitary bees*. On: http://blog.creaf.cat/en/coneixement/adventures-nest-making-solitary-bees/?platform=hootsuite. Website on solitary bees and their nests.

- Proyecto Apolo (2010). *Observatorio de agentes polinizadores*. On: http://apolo.entomologica.es/. Website with teaching material for all school groups, combined with very useful technical reports to know more about pollinating insects.

- The Wildlife Garden Project (2011). *A guide to building a bug hotel!* On: https://www.youtube.com/watch?v=3hrjD089bTg. Audio-visual material about how to build an insect hotel. Duration: 08:05 minutes. Language: English.

- Wild About Nature (2013). *Making An Insect Hotel For Many Different Creatures Part 1*. On: https://www.youtube.com/watch?v=ULfN_8XHzmY. Audio-visual material about how to build an insect hotel. Duration: 05:23 minutes. Language: English.

5• Activities for secondary education- and upper secondary education students

The activities proposed for people aged between 12 and 17 are the following:

Activity 1.- Observation and identification of pollinators

Activity 2.- The scientific method

Activity 3.- Data collection about pollinators

Activity 4.- Data analysis

Activity 5.- Building an insect hotel

In order to introduce the activities, the teacher can select any of the audio-visual materials listed in section 2.4 to supplement the introduction to each activity.

5.1. Activity 1 Observation and identification of pollinators

Duration (approx.)	Necessary space	Recommended groups	Recommendations
2 h 30 min. It can be performed in 1, 2 or 3 sessions	Classroom and green area	15 persons per educator. Work in pairs	Nearby green areas, when the weather is warm preferably

Objectives

- Identifying the major groups of pollinating insects.
- Familiarising with insect observation and identification techniques.
- Becoming aware of the importance of entomofauna and the pollination process, both for the ecosystems and our everyday life.

Timing

- Presentation of the workshop 10 min
- Theoretical introduction about pollinators and pollination 45 min
- Entomofauna identification practices 45 min
- Field practices of observation of pollinators 40 min
- Sharing of knowledge and closure 10 min

Materials and other requirements

- Computer, light cannon and screen
- Insect samples
- Hand and binocular magnifiers (the latter are not essential)
- Identification keys and hand magnifiers (at least one per each pair)
- *Bichos de tu entorno*, teaching notebook, available for free download on https://goo.gl/Nn1xf7
- *Los polinizadores más comunes de las zonas vedes de Madrid* teaching notebook, de Ruth Escobes
- A park, orchard or garden **with plants with flowers nearby**

Development

Presentation of the workshop

The contents of the project, the activities, objectives and contents are presented before the activity starts.

Theoretical introduction about pollinators and pollination

Pollination is explained and pollinating insects are identified as actors of this process. The particularities of each insects within the animal kingdom are outlined. To that end, the teacher can use the videos outlined above. The website: http://apolo.entomologica.es/index.php?d=materiales, includes lesson plans, as well as educational brochures and triptychs for all educational levels.

Entomofauna identification practices

For this part of the activity, it is advisable to use **samples of the most** common specimens in the Iberian Peninsula, notably pollinating insects. Such samples should be individualised and safeguarded, whether using resin or methacrylate boxes to facilitate their observation and ensure enhanced conservation (pictures 10, 11 and 12). Information on how should entomological samples be prepared is provided in the additional information section.

It is advisable to start the activity by reviewing the insect's morphology and provide enough information on terminology allowing a proper understanding of the teaching guides.

Identification shall be performed in pairs, although it can be performed individually if there is enough material (pictures 8 and 9). Students shall be provided with an arthropod's sample that he/she has to identify using a guide. It is advisable to use simple insect guides, such as *Bichos de tu entorno*, which can be downloaded on the website referred to in the "materials" section. These samples should be observed using hand or binocular magnifiers. The latter can be used to take a detailed look at the different parts of the insect, such as mouthparts or butterfly wings.

Picture 8

Picture 9

Field practices of observation of pollinators

Once the students are familiar with the entomofauna's observation and diversity, it is time to go out in nature to observe those insects around us. Pollinating insects are more common in green areas with plenty of plants in flower, which are their food. Orchards are normally very good sampling areas. Gardens and green

areas should have flowering bushes such as Labiates, Leguminoseae or Rosaceae, very frequent in gardening. The best time of the year to observe pollinating insect is between March and June, the phenological time when the flowers of most plants are fully developed. It should also be noted that the middle of the day -with warmer temperatures- is the best time of the day for observation. This is due to the fact that, on the one hand, warmer temperatures make metabolism and thermoregulation of insects easier and, on the other hand, plants release their volatile oils whereby insects are more attracted to them. Patience is always necessary to look to nature; it always takes time for the human eye to get used to the size and flight of insects. The teaching guide called *Los polinizadores más comunes de las zonas verdes de Madrid*, available for free download (see bibliography), may be useful to develop this activity.

Sharing of knowledge and closure

At the end of the observation, it is interesting that students share their knowledge to highlight what they learnt, the difficulties faced and how to overcome them. Here are some questions that teachers can ask while students share their knowledge:

- Did you find many different insects?
- What are the most common insects in our area?
- Do you think they are so common in other times of the year as they are now?
- What were the insects observed by us doing?

Additional information

Insect collection and conservation

Normally, entomological samples are not available in advance. They can be obtained by insects them upon applying for a licence before the competent body, or -and this is a far more advisable, but slower option- by collecting dead specimens in good condition (which is relatively easy in our towns and cities). Therefore, the populations of pollinators are not decimated, notably if we do not have any in-depth knowledge of the species captured, as they may be endangered. Even when collecting dead specimens, it is advisable to apply for a licence from the Administration. On the entomological samples are obtained, they can be kept either in synthetic resin, which can be found in the specialised market (pictures 10 or 11) or in individual methacrylate boxes (picture 12) to facilitate their handling

and observation. Keeping samples in resin has the advantage of longer durability, greater resistance and the possibility to observe the samples from any angle. You can find three examples below:

Picture 10

Picture 11

Picture 12

For more information about insect preservation techniques, please visit the following websites:

- Márquez Luna, J. (2005). "Técnicas de colecta y preservación de insectos". *Boletín Sociedad Entomológica Aragonesa*, n1 37: 385–408. On: http://sea-entomologia.org/PDF/GeneralInsectorum/GE-0056.pdf
- Melic, A. y Melic, D. (2015). *Recopilación de artículos sobre consejos y técnicas de captura, colección y cría de insectos*. On: http://sea-entomologia.org/consejosytecnicas.htm.

Guías entomológicas

- Aguado, L.O., Fereres, A. y Viñuela, E. (2015). *Guía de campo de los polinizadores de España*. Mundiprensa.
- Chinery, M. (1997). *Guía de campo de los insectos de España y de Europa*. Omega.
- Escobés, R. y Vignolo, C. (2018). *Los polinizadores más comunes de las zonas verdes de Madrid*. On https://goo.gl/wvoYks.
- Harde, K.W. (1984). *Guía de campo de los coleópteros de Europa*. Omega.
- Novak, F.G.F.S. (1984). *Guía de campo de las mariposas de Europa: diurnas y nocturnas*. Omega.

- Real Jardín Botánico de Madrid, CSIC (2015). *Bichos de tu entorno. Guía de insectos y otros artrópodos*. CSIC.
- Rivera I., Melic, A. y Torralba, A. (2015). *Introducción y guía visual de los artrópodos*. IDE@-SEA: 2 (1-30).
- Vicente Arranza, J.C. y García Carrillo, A. (2009). *Mariposas diurnas de la Comunidad de Madrid*. Ediciones La Librería.

Websites

- Nicholls, S. *Grandes Documentales. Grandes Bichos*. On: https://www.youtube.com/watch?v=e4UG-4BZKYI. Documentary on insects belonging to the "Grandes Documentales" series. Duration: 50:25 minutes. Language: Spanish.
- Varma, A. (2015). *Amazing Time-Lapse: Bees Hatch Before Your Eyes. National Geographic*. On: http://www.thisiscolossal.com/2015/05/an-extraordinary-glimpse-into-the-first-21-days-of-a-bees-life-in-60-seconds/. Development of bees from larvae to adults: Duration: 01:08 minutes. Language: English.

5.2.Activity 2 The scientific method

Duration (approx.)	Necessary space	Recommended groups	Recommendations
1 h	Classroom	15 persons per educator	...

Objectives

- Knowing the steps to follow to make science.
- Designing an ecological study through scientific methodology.

Timing

- Theoretical introduction about the scientific method in ecology 20 min
- Experimental design practice 40 min

Materials and other requirements

- It is advisable to use a blackboard or a flipchart.

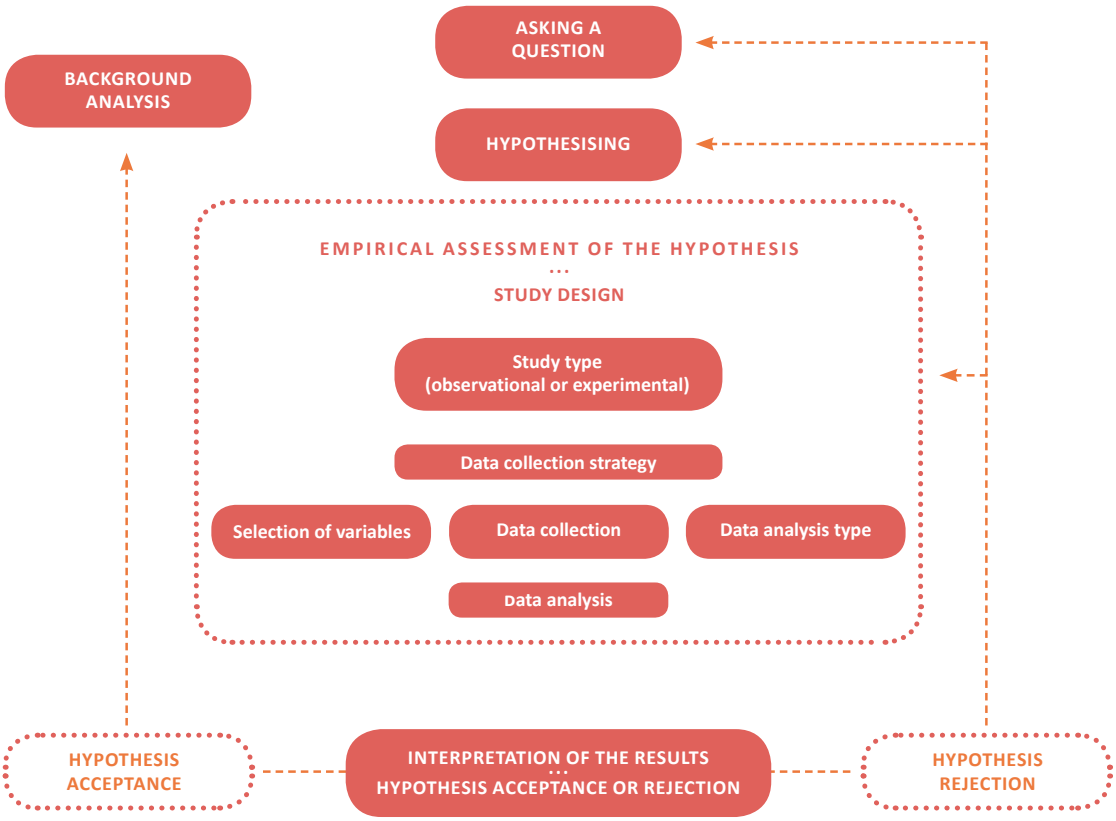
Development

- **Theoretical introduction about the scientific method in ecology**

  The activity starts with a theoretical introduction about the scientific method in ecology.

  The **scientific method** is a working methodology based on the development of an ordered series of steps to respond an unresolved scientific issue. These steps are: hypothesising, experimental design, systematic observation, experimentation, analysis and responding to the initial hypothesis. This method involves the experiment's reproducibility.

  These steps are represented in the following diagram:



Graph 1: Diagram representing the structure of a research following the scientific method (Department of Ecology UAH, 2005)

Experimental design practice based on the scientific method

In this practice, students **make an experiment design practice**. whether in groups or individually. For this purpose, a subject close to the environment that can be studied through the scientific method is selected.

A simple example is then given:

- Question: do primary education students grow faster than upper secondary students in our educational establishment?
- Hypothesising: "Primary education students grow faster as they are in a faster growth period in humans".
- Study design: the variables that may describe the phenomenon studied are identified (dependent variables), as well as the causes that may affect such phenomenon (independent variables) and how they are measured.
    - Dependent variable: students' height.
    - Independent variable: students' age (more variables can be identified).
- Data collection strategy:
    - Sampling unit: a student.
    - Sampling frequency and units: the dependent variable shall be measured on a quarterly basis during the school year among 30 students of Year 2 of primary education and Year 1 of upper secondary education.
- Data analysis: a mathematical analysis to compare the growth rate (length/time) of each of the groups selected (by age) shall be performed.

This exercise shall be performed in groups from a dialogical perspective, so that students can participate in the design thereof. A similar exercise shall subsequently be performed to conduct a field survey of pollinators in our region. Here are some questions:

- What is the most common type of insect in our school playground?
- Do Lepidoptera prefer a specific type of flower?
- Do bees prefer a specific colour of flower?

It is advisable to choose a question and new questions that should be answered following the same steps may arise after answering it (following all the steps of the scientific method). It is important that teachers highlight that searching for scientific literature is the first step before any sort of research is conducted, in order to know whether the question has previously been answered.

Additional information

Bibliography

- Departamento de Ecología UAH (2005). *Métodos de investigación en ecología*. On: http://www3.uah.es/tiscar/Eco_Biol/Complementos_Eco/Cuaderno%20metodos%20investigacion05.pdf.

- Martella, M.B. *et al.* (2012). *Manual de Ecología Poblaciones: Introducción a las técnicas para el estudio de las poblaciones silvestres*. Reduca (Biología). Serie Ecología. 5 (1): 1-31.

- Méndez Iglesias, M. (2003). *Diseño de trabajos de campo en ornitología: una guía para rompetechos*. On: http://www.bio-nica.info/ALAS/pdf3.pdf.

5.3. Activity 3.- Techniques to collect data on pollinators

Duration (approx.)	Necessary space	Recommended groups	Recommendations
2 h 30 min. It can be performed in 1 or 2 sessions	Green area	15 persons per educator	It is advisable to used mobile phones or photo cameras and computers with internet connection

Objectives

- Identifying the main sampling techniques of pollinating insects.
- Conducting a pollinator census
- Participating in the collection of biodiversity findings through the **Natusfera** citizen's science biodiversity platform to register, know and identify species.

Timing

- Theoretical and practical workshop about the Natusfera platform 60 min
- Conduction of pollinator census 60 min
- Sharing of knowledge and data analysis 30 min

The activity can be performed in one or two consecutive sessions in order to facilitate its implementation.

Materials and other requirements

- Orchard of garden.
- Internet connection.
- Computer, mobile phones (preferably with internet connection, although it is not essential) or digital camera if there are not any mobile phones available.
- Identification keys and hand magnifiers (at least one per each pair).

Development

- **Theoretical and practical workshop about the Natusfera platform**

Natusfera is a **citizen's science digital platform to know the biodiversity of all kinds of organisms**, a place to register and arrange nature **findings,** to meet other enthusiasts and learn about the natural world. It is operational under the form of a website (http://natusfera.gbif.es/) and a mobile application. It is participatory, open and user-friendly so that anybody can participate and share his/her findings.

Findings can be grouped by projects and each one must include at least one picture or sound recording of any organism, together with the location, date and time it was recorded. Any other relevant information of an ecological nature can also be collected. The Natusfera system validates identifications supported by all the contributions made by users, some of them are experts with greater impact on such validation.

Thanks to all these functions, Natusfera is an excellent learning tool for education that shall allow for our findings to be registered and organised and that shall also be useful for identification purposes. At present, there is a project called **SOS Polinizadores** (http://natusfera.gbif.es/projects/sos-polinizadores), within Natusfera, where **findings of pollinating insects of Madrid are included**. It is an open project; therefore, any platform user can include his/her findings in this project (it is some kind of findings folder).

At this stage of the activity, the students shall familiarise themselves with the use of this platform to collect data. To that end, after presenting the platform and how it works in the classroom, the green area selected shall be visited and the plant and animal species observed shall be registered using the mobile phone. If you do not have a mobile phone, pictures of the findings can be taken and uploaded to the **Natusfera** website using a computer.

It is recommended to see the additional information regarding this activity in order for teachers to learn to use this platform.

Also note: http://natusfera.gbif.es/pages/help

- **Conduction of pollinator census**

Censuses allow us to estimate how many specimens of a species live in a specific area. To conduct a census, it is advisable to work in pairs or in groups of three

persons. The plant under study is selected and its flowers are counted. It the plant is very big and has many flowers, a specific section is then selected in order for it to be duly observed. The number of flowers in that section is then counted (or an estimate is made if there are many flowers). The number of visits made to each flower by the visitor is then counted. Observation lasts for 5 minutes.

The report included in the additional information section of this activity can be used during the data collection stage. Depending on the question asked in activity 2, data collection during the census conduction process may vary to answer such question.

Picture 13

Picture 14

- **Sharing of knowledge and data analysis**

Knowledge is shared at an initial stage through group discussions using the data collected. It is advisable to attain the highest possible participation level. It is also advisable to promote discussions supporting each finding shared, so that each opinion can be questioned using reasons based on biological principles. Here are some questions:

- What is the most common species in the study area?
- Do you think insects prefer a specific plant species?
- Do you think they are so common in other times of the year as they are now?
- Data shall be analysed mathematically (activity 4)

Additional information

Guide for the experimental design and sampling

1. Presentation of the ecological study
2. Hypothesising
3. Design of the sampling protocol

a. Variables

Type of variable	Variable	Qualitative or quantitative
Independent variables		
Dependent variables		

b. Sampling unit: size of the sampled space, sampling time

c. Distribution of the sampling units:

   i. Please specify the strata:

   ii. How are samples distributed in each stratum (systematically, randomly, based on gradients)

d. Number of sampling units (total number and number per stratum)

e. Statistical method to be used

Standard report to conduct a pollinator census

POLLINATOR CENSUS

Date_____ **Time**_____ **Sample time:**_____ **min**

Weather:

Sunny ☐ Cloudy ☐

Others_____

Temperature:

Warm ☐ Fresh ☐ Cold ☐

Temperatura_____

Plant species	Number of flowers	Pollinator species	N.º of visits	Findings

Bibliography

- CREAF (2017). Natusfera. On: http://natusfera.gbif.es/
- GBIF (2001). *Nodo Nacional de Información en Biodiversidad.*

5.4. Activity 4.- Data analysis

Duration (approx.)	Necessary space	Recommended groups	Recommendations
2 h 30 min. It can be performed in 1 or 2 sessions	Green area	15 persons per educator, in small groups	It should be noted that the experiment's implementation may take a few days or weeks

Objectives

- Students shall learn to analyse data using mathematical tools.
- Students shall be able to interpret the data analysed, draw conclusions and argue them.

Timing

- Experimental design about pollinators 45 min
- Experiment implementation* 45 min
- Data analysis and drawing of conclusions 45 min
- Result reporting 60 min

*It is important that in order for the experiment to be implemented and depending on how the experimental design is performed, it normally takes several data collection attempts for over several days or weeks.

Materials and other requirements

- Field amplifiers, field notebooks, identification guides and mobile phone if Natusfera is used.
- Computers for statistical analyses.
- Computer, light cannon, screen and stationery to report the results.

Development

- **Data analysis and drawing of conclusions**

Using the data obtained in the field work, the scientific method proposes a statistical analysis to validate or question the hypothesis. This a complicated procedure that requires previous knowledge on statistics. Nevertheless, we propose a simple comparison of sample means to determine whether there is any difference between data groups to be compared in each study. We know that it is not enough to validate our hypothesis before the decision-making process in terms of science, but we believe it is illustrative to analyse data as far as science teaching is concerned. During the conclusion-drawing process, it is important to know and reflect any possible mistakes or error made throughout the experiment and the analysis, which may have an impact on the results.

Additionally, the results obtained should be construed through argued discussions based on scientific literature and aligned with biological principles. This discussion and arguing stage is a very powerful teaching element as it fosters logical reasoning, interrelations and links between different data and knowledge.

- **Result reporting**

Once the scientific study has ended, each group shall present its results to the other participants. These presentations can be done under different forms, whether orally, as a poster or under any other form of the plastic or performed arts preferred by each group. This way, the multiple intelligences described by Gardner are at stake, combining different forms of expression. Oral, written or plastic communication is a basic skill that must be acquired throughout both primary and secondary education.

A proposal to report the results consists on organising a little congress where each group presents its findings. It is important to network with other educational establishments or entities that are implementing the SOS Polinizadores project and to organise the event together.

Información complementaria

- Gorgas, J., Cardiel, N. y Zamorano, J. (2011). *Estadística básica para estudiantes de ciencias*. On: http://webs.ucm.es/info/Astrof/users/jaz/ESTADISTICA/libro_GCZ2009.pdf

- Méndez Iglesias, M. (2003). *Introducción a la estadística para ornitólogos que odian el Ardeola*. On: http://www.academia.edu/28396312/INTRODUCCI%C3%93N_A_LA_ESTAD%C3%8DSTICA_PARA_ORNIT%C3%93LOGOS_QUE_ODIAN_EL_ARDEOLA

5.5. Activity 5.- Building an insect hotel

This activity is described in the Activity 3 for primary education section. It is recommended for secondary education students as a project ending in order for students to perform an activity aimed at conserving insect populations from the green area closest to their educational establishment.

Hotel de insectos construido para el Real Jardín Botánico.

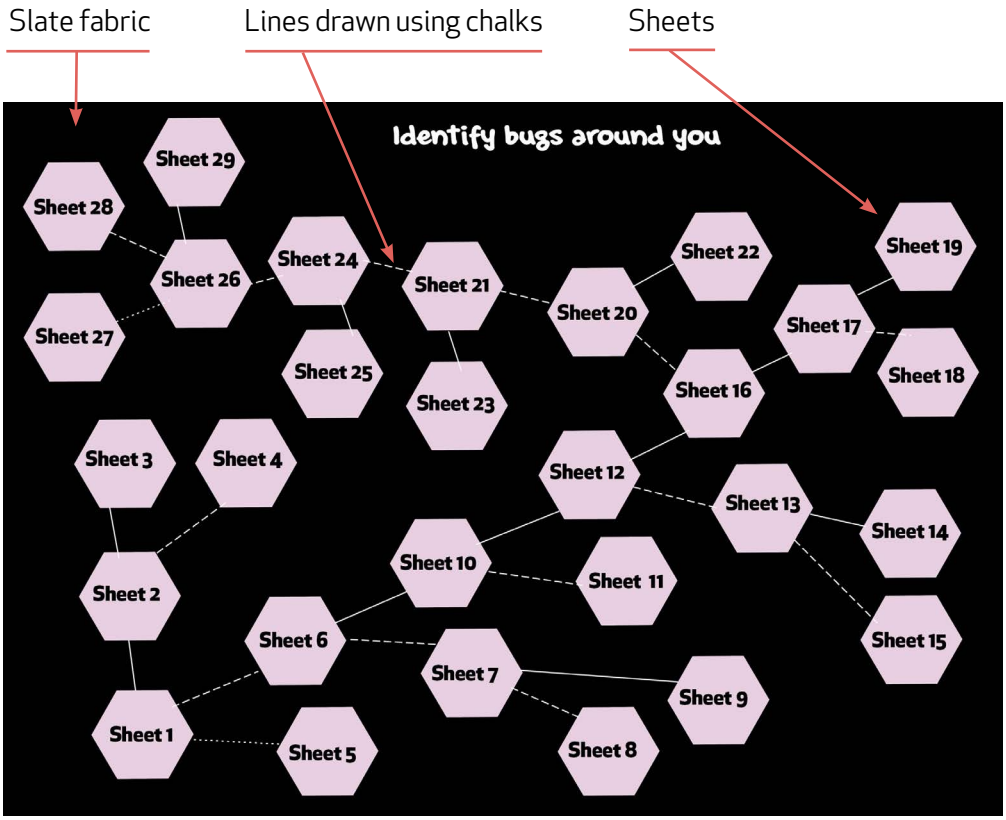
SCHEDULE: GAME: "Identify bugs around you"

- **Game presentation:** in groups, the students have to identify the arthropod in front of them. To that end, a person from the group reads the hexagonal cards from square one. At the beginning, all sheets are turned over (hidden using the first hexagonal card). Way forward is selected from square one until we reach the species.

- **Required materials:**

1. Insect collection in resin or stuffed (bibliography about insect conservation is included in page 29)
2. Game diagram
3. Slate fabric
4. White chalk to mark slate with line
5. Thread and needle to sew cards to fabric
6. Hexagonal cards
7. Laminating device to protect cards

1. Game diagram



2. Hexagonal cards:

The back, which is common to all sheets, can be used to hide information appearing in the front at the start of the game:

Back

Sheet 1

Take a look at the number of legs of the arthropod in front of you and count:

 If it has 6 legs ———

 If it has 8 legs --------

 f it has more than 8 legs .....

Sheet 2

¡You got to the ARACHNIDS group!

Spiders, ticks, scorpions and mites belong to this family. Most of them are predators that suck fluids. Some of them inject paralysing venom into their victims! Now look at the arachnid in front of you and analyse its shape.

 It is big and long. It has big claws on its head. ———

 It does not have any big claws. ------

Sheet 3

Be careful, it is a scorpion!

Common scorpions or alacrans **have a tail with a poisonous sting in the end** of it. Getting stung by a scorpion is extremely painful. They live under the stones and in the night, they hunt arthropods on which they feed. Its Latin name is "Buthus occitanus".

Sheet 4

It is a spider!

This insect produces **silk threads to trap its preys,** build tunnels and move.

Sheet 5

You got to the MIRIAPODA group!

Centipedes and millipedes belong to this family. Their body is made up of the head, a long thorax with many segments and several pairs of legs. Many of them hide from light and search for humidity, therefore the live under the stones during the day. This millipede is an example.

Sheet 6

You are in the INSECT group!

All Insects or Hexapoda **have 6 legs** and two pairs of wings, although some of them, such as beetles, have very hard wings and ants have even lost them. Their body is divided into three sections: head, thorax and abdomen.

Its hind legs are strong and muscled ——

All legs have a similar size --------

Sheet 7

You got to the ORTHOPTHERA group!

Crickets, grasshoppers and locusts belong to this family. Hind legs are strong and muscled to jump.
Analyse the insect in front of you and look at its shape:

Its body is long and light brown

_____

It is smaller and yellowish

Sheet 8

This insect is a GRASSHOPPER!

Herbivorous insect that can be a serious pest for agriculture. Grasshoppers can jump 20 times the length of their body.

Sheet 9

This insect is a CRICKET!

In the nights, notably in summer, crickets make that peculiar sounds by rubbing their wings.

Sheet 10

Analyse the insect in front of you. Analyse its wings

- Both wings are hard and look like shields _____
- It has one or two pairs of visible wings or does not have any --------

Sheet 11

You got to the COLEOPTERA group!

They have two pairs of wings. Their outer wings are called elytra and make up some kind of shell. Almost 50% of all insects in the world are beetles! Most of them feed on plants.

Sheet 12

Analyse the insect in front of you. Analyse its wings:

 They are smooth and silky. Bring the magnifier a bit closer. ———

 They are covered with very small scales. ---------

Sheet 13

You got to the LEPIDOPTERA group!

Moths and butterflies are included in this group. There are more than 113,000 butterfly species in the world!

Look at its antennae

The end looks like a small button ———

They have feathery antennae ------

Sheet 14

Congrats, **this insect is a butterfly!**

They feed on flower nectar, contributing to their pollination. They absorb nectar using their proboscises, a long tube they can roll when they are not gathering nectar. This species is called "Papilio machaon".

Sheet 15

You got to the **moths!** They look like butterflies but they have nocturnal habits. Their colours are less striking and can fold their wings sideways. The moth in front of you is a giant peacock moth called "Macroglossum"

Sheet 16

Look at the insect in front of you carefully

It only has **2 wings**, one on each side of the body ———

It has **4 wings**, two on each side of the body -------

Sheet 17

You got to the DIPTERA group!

Flies, mosquitoes and horseflies belong to this group. They have other pair of wings not visible to the naked eye called "cradles" that they use to control their flight direction. They also have a big pair of compound eyes in their head. Look at the diptera in front of you

It is black ———

Its colour looks like that of a wasp ------

Sheet 18

Eureka, it is a FLY!

Some flies feed on decaying substances but their function is very important in nature as they help to recycle organic matter on the dirt. Other flies feed on nectar and play an important role as pollinators.

Sheet 19

The insect you are identifying is a syrphid!

When adult specimens of these Diptera gather nectar from flowers, they look like Hymenoptera such as bees and wasp, so they can be easily confused with them. Their Latin name is Syrphus sp.

Sheet 20

Analyse the insect in front of you.

It has two big compound eyes in its big head and a long abdomen divided into segments. ———

It does not have any big eyes and its abdomen is not divided into 11 segments. --------

Sheet 21

You got to the
HYMENOPTERA group!

They have two pairs of wings. Their outer wings are called elytra and make up some kind of shell. It is one of the largest insect groups, with more than 200,000 species. Look at the hymenoptera in front of you:

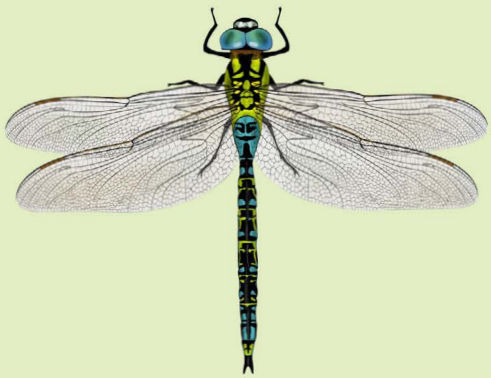

It does not have any wings ———


It has two pairs of wings ------

Sheet 22

This insect is a dragonfly!

They mainly live in summertime. They live close to freshwater areas, such as ponds. 300 million years ago, dragonflies were as big as a person!



Sheet 23

Congrats! You made your way to the ants group!

Ants live in colonies made up of millions of specimens. They are well organised and communicate by pheromones, chemical substances that alert them of a danger or where to get food.

Sheet 24

Analyse the insect in front of you.

 It has a thin body and its waist, between its thorax and its abdomen is narrow. _____

 It has a thicker body without any waist between the thorax and the abdomen. ------

Sheet 25

Congrats! The insect in front of you is a wasp!

They are social insects that live in swarms. Many of them feed on nectar and are thus great pollinators. Others are predators and feed on other insects.

Sheet 26

Look at the insect in front of you:

 It has a long body ———

 It has a rounded, yellow and black body ------

 It has a rounded, purplish black body .....

Sheet 27

Congrats! The insect in front of you is a wasp!

There are **many different species.** Only a small portion are social and live in hives. Most of them are solitary bees. They play a very important role in transport pollen (pollination) using the baskets in their legs.

Sheet 28

This insect is a BUMBLEBEE!

They belong to the "Bombus" genus. They are **social insects.** Queens survive the winter and nest under the ground, where they lay eggs. When larvae come out, they food on a delicious "bee bread", a combination of pollen and nectar prepared by the queen.

Sheet 29

It is a CARPENTER BEE!

It belongs to the "Xylocopa" genus. It is called carpenter because it can build tunnels inside wood to nest. These pollinators feed on the flowers' nectar. You have seen them on more than one occasion for sure: they are big and black-purple.

SOS
Polinizadores

Teacher's &
environmental educator's guide

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