PLANT PROTECTION INSPIRED BY NATURE

What can we learn from nature about protection?

Erasmus+

AGE RANGE

12–14

DURATION

Preparation:
60 min.

Activity:
180 minutes / 4 lessons

SUBJECT(S)

- Science – *Biology, Chemistry*
- Design, Engineering and Technology
- Arts

KEYWORDS

Pest-predator relation-ship; natural pest control; biodiversity; food chain

SUMMARY

In order to stay alive and healthy we need to protect the environment, our body and our food (and crops) against damage. How can we do this without harming other living organisms on the planet? In this module, students will explore plant protection inspired by nature. In the final activity, students design small project to increase biodiversity and natural pest control in a school or community garden.

BIOMIMICRY PRINCIPLES

3 – Nature fits form to function
5 – Nature rewards cooperation
6 – Nature banks on diversity
7 – Nature demands local expertise

LEARNING OBJECTIVES

- Students understand that industrial farming requires a heavy use of artificial pesticides and fertilizers.
- Students understand the ecological links between organisms, and are able to find inspiration in nature for plant protection.
- Students understand that the closer agriculture mimics natural systems, the less problems with pests.
- Students gain skills for ecological gardening.

LEARNING OUTCOMES

- Students ask questions and research answers in the field of bio-inspired plant protection.
- Students explain biological pest control, and provide examples about how to protect plants or fruits against different pests.
- Students design a small project to increase diversity in a garden, and attract predators to control the pest population.

BIOLEARN COMPETENCES

- Students are able to abstract principles of sustainability from the way the natural world functions.
- Students are able to identify functional design in nature, develop greater awareness and appreciation for design excellence in nature, and appreciate how nature works as a system which is elegant and deeply interconnected.
- Students are able to assess the consequences of applying biomimicry solutions (values).
- Students are able to work in groups.
- Students are more motivated in learning STEAM and experience that knowledge of STEAM can be widely used.
- Students become more familiar with professions and research topics that relate to nature-inspired sustainability and technological innovation, which can inform their choices in post-secondary education and careers.

SUMMARY OF THE ACTIVITIES

	Activity Name	Description	Method	Duration	Location
1	Find a plant or structure	Students associate plants or natural structures with their functions	• Quest • Observation (sensing)	20	Outdoor
2	Two faces of agriculture: which one is closer to nature?	Students explore problems of large-scale farming with a focus on pests	• Card sort	25	Indoor
3	Spanish slug: nightmare of gardeners	Students explore the Spanish slug and design strategies to control them	• Survey	20	Indoor
4	Each pest has its predator	Students investigate ecological principles and their use for plant protection	• Card sort	25	Indoor
5	EcoLogical pest control	Students investigate one pest and develop bio-inspired control measures	• Research • Student presentation	45	Indoor
6	Shelters for predators	Students apply knowledge to design/produce nature-based tinctures or ointments	• Student presentation	45	Indoor

BACKGROUND FOR TEACHERS

According to a study of Wageningen University, pesticide residues are present in more than 80% of European agricultural soils. (Source: https://www.wur.nl/en/newsarticle/Pesticide-residues-present-in-more-than-80-of-European-agricultural-soils.htm). Is there a way to minimize their use, to prevent environmental damage and reduce health hazards?

In this module students will discover how nature protects plants and what we can learn from that for growing and protecting our crops. Students will discover that the answer can be found in the relationship between pests and predators, their natural enemies. This is the basic principle of biological plant protection – to identify and encourage the predators of pests.

Knowledge of biology, ecological principles, knowledge of their way of life, reproduction (whether pests or their predators), knowledge of their place in food chains etc. will help to propose strategies for encouraging predators to pest-infested vegetation, whether in the field or in the garden.

Throughout the module, students will discover how to transfer good examples from nature to more environmentally friendly farming practices. They will recognize some beneficial insects and gain basic understanding to grow their own healthy harvest, without unnecessarily fighting nature.

In the last activity, students will implement their knowledge in attracting "garden helpers", and design shelters for them: a hedgehog heap, insect house, bird box, and a pond. If there are suitable conditions at school, they can implement one of the projects, and increase of biodiversity in the school garden. If not, they will elaborate their proposal in the form of a short video or ppt.

How can we protect the crops that we grow for food?
Conventional agriculture often uses chemicals to protect plants from pests – pesticides (insecticides against insects, fungicides against fungi and moulds, rodenticides against rodents, herbicides against weeds). All forms of biocides are made to kill anything that could hurt food plants.

Chemical pest control was developed to increase food production due to large increases in population and changing dietary requirements. The pressure for increasing production efficiency and low food prices has resulted in more monocultures, synthetic fertilizers and chemical plant protection products. This development in agriculture (but also by analogy in horticultural practice) took place mostly in the 20th century.

The use of chemical plant protection is considered normal today, although it has very negative effects on the environment such as the loss of biodiversity in agricultural areas (pesticides kill not only pests but also beneficial organisms), soil, surface and even groundwater pollution, accelerated soil degradation, without the possibility of its regeneration and overproduction of greenhouse gases.

Pesticides also present some health risks, especially for workers on farms who work with them, small children and the chronically ill (the effects of multiple chemical cocktails are not well studied). The problems of current conventional agricultural practice are, of course, much more.

See https://www.foodspan.org/lesson-plans/ for more info about challenges in the current food system.

ACTIVITY DETAILS

LOCATION
Outdoor

PREPARATIONS

Outdoor activity – school or community garden.

1| FIND A PLANT OR STRUCTURE

» CREATE
» QUESTION

Garden quest. Students search in the garden for a plant or structure that attracts or repels. Students share their ideas, and try to identify ways in which these plants or structures may help in bio-inspired plant protection.

What function does a plant or garden structure have?
Introduction: The teacher asks students to think of a garden. Does anyone remember something special in terms of plant protection? E.g. plants or other strategies to support the health of vegetables and fruits to avoid chemical sprays? Students share their ideas (they can come up with e.g. bee-hive, physical barrier around strawberries, vegetables and flowers in mixed patches, aromatic plants between vegetable beds, nettle extract against aphids).

Then, the teacher assigns a small garden quest: Find a plant or a structure which attracts/invites or repels/makes a barrier (e.g. by smell, colour, shape, surface, material...). After a couple minutes, each student presents the plant or a structure and suggests its function. Does it attract / invite? Or repel / makes a barrier?

Students could find “something prickly or sticky”, which are ways for example roses are effectively protected from Spanish slugs (they do not climb on the stem with thorns) or how conifers prevent resin outflow from infecting a wound. These observed strategies can inspire the search for new ways to protect plants (e.g. sticky resin analogy = sticky strips around tree trunks to prevent ants; or thorns analogy = creating barriers for slugs in the form of sharp eggshells).

Students return to their classroom, and explore the question how some of these plants or structures help in keeping ecological balance in the garden or in the field, and why it is important to learn more about them.

Variation for distance learning
Students should visit their own garden, a nearby park or the nearest patch of nature from their home. The task is to find something aromatic or prickly. They take a photograph of their discovery on a mobile phone, and share it online with the group. *Question:* How does the discovered property (smell, thorn, etc.) protect the plant from the pest?

Another tip is that students should find a parallel of this natural property with the world of people and create a pair, e.g. barbed plants – pointed fence = barrier against unwanted guests (the pair may be illustrated by a photo or picture).

Sharing discoveries and parallels, evaluation and discussion on the topic can take place in an online class.

2| TWO FACES OF AGRICULTURE: WHICH ONE IS CLOSER TO NATURE?

» CREATE

LOCATION
Indoor

TOOLS AND MATERIALS

Student worksheet W2.1 – a set of cards

PREPARATIONS

Indoor activity.

The classroom needs to be adjusted for group work.

Print a set of card per group.

Students work in groups with sets of cards (W2.1). Each pair of cards represents two faces of farming techniques – more or less ecologically balanced. They discuss in small groups what is in the pictures and justify which picture from each pair is closer to nature, in which cases and WHY the increased need for pesticides in plant protection is needed. At the end, the teacher sums up sustainable vs. unsustainable farming practises with focus on plant protection.

The students' task is to describe what is in the pictures, arrange them into logical pairs and justify which picture from each pair is closer to nature.

The activity takes place in such a way that the teacher distributes a set of pairs of pictures to groups of students (the teacher cuts the cards from worksheet W2.1, distributes the whole set of cards to each group of students) and gives them the task to arrange the pictures into logical pairs. Subsequently, a discussion takes place, the students (groups of students take turns answering) describe the pictures / pairs of pictures, determine which of the pairs of pictures shows closer / more distant agricultural practice and consider whether it is necessary to use plant protection pesticides, how many and why. The teacher directs the discussion, or adds information.

Final discussion facilitated by teacher: people need to produce more food for the fast-growing population. (Part of the problem is also enormous food waste, and eating too much meat). The larger monocultures are, the more effort / energy is needed to protect them from pests.

In order to minimize the need for chemical pest control, we should learn to "copy" patterns / design from nature. Maintaining high biodiversity in agroecosystems is a key measure to make our agricultural production more sustainable, to support biological crop protection, crop pollination, fertility of soil and water retention capacity of soil.

» QUESTION

- Do monocultures exist in natural ecosystems?
- How do plant organisms prevent themselves against pests in nature?
- Are plants chemically protected against pests? Mechanically? Otherwise?

Variation for distance learning
The activity can be presented to students in an online lesson, or also in the form of a presentation by the teacher with homework: during walks close to your home, find one example of nature-friendly and one example of intensive farming practice, and take photos to illustrate each. Write a short text to describe both photos. Summary of all photos could make a small guide of good/bad agricultural practice.

LOCATION
Indoor

3| SPANISH SLUG: NIGHTMARE OF GARDENERS

» DISCOVER
» CREATE

TOOLS AND MATERIALS

- Student worksheet W3.1: Info-sheet Spanish slug
- Student worksheet W3.2: How to control Spanish slug?

PREPARATIONS

Indoor activity.

The classroom needs to be adjusted for group work.

Print the W3.1 and W3.2 worksheets according to the number of groups.

RESOURCES

20 Ways to control slugs in the permaculture garden or on the allotment

Killing Slugs & Snails: the "Humane" Way? Common Mistakes and Effective Alternatives

Each group will receive a copy of info-sheet (W3.1) and worksheet (W3.2) – Spanish slug. Based on the given data (or online search) they suggest, explore and rank various methods of Spanish slug control.

Questions to rank how good or bad individual measures are:

- Is it a chemical or biological measure?
- Is it a short-term or long-term measure?
- How much do they suffer before they die?
- How costly is the measure?
- Is it more about the fight against slugs or about protection of gardener's plants?

Variation for distance learning
Study the description of the Spanish slug, try to find it in your garden and observe its behaviour. If you do not find a Spanish slug, you can also observe an ordinary garden slug. You can use for observation an aquarium or a large glass container. Try to create an environment close to nature: include moist soil, something as a shelter (for example a piece of wood under which it can hide), lettuce leaves, etc. Observe his behaviour in such a "laboratory" environment for at least one week. Did you notice anything interesting? Be sure to release any creatures safely after your observations.

If you do not know how to find a Spanish slug in the garden, try laying a board on the ground near the vegetable bed and in a few days examine which animals found the board as a shelter. Have a look who hid under the board; any Spanish slugs?

LOCATION
Indoor

4| EACH PEST HAS ITS PREDATOR

» CREATE

TOOLS AND MATERIALS

- student worksheet W4.1: set of cards – drawings
- student worksheet W4.2: set of cards – labels
- teacher's page T4.1

PREPARATIONS

Indoor activity.

The classroom needs to be adjusted to group work.

Print one set of cards per group.

RESOURCES

- Insect identification: https://play.google.com/store/apps/details?id=com.mm.insects.identification&hl=sk&gl=US
- Beneficial insects: https://nospray.org/2017/03/21/beneficial-insects-alternatives-to-pesticides/
- Bird identification: https://play.google.com/store/apps/details?id=de.tu_chemnitz.mi.kahst.birdnet&hl=sk&gl=US

Students are given cards with pictures and labels. Their task is to group them correctly according to the key (seeT4.1). After completing the work in a group, students present how the cards were arranged. If needed, the teacher can rearrange them correctly.

Each group of students receives a set of cards with pictures W4.1 and labels W4.2. All cards need to be cut in advance. The task of students is to group them correctly according to the key: picture of a cultivated plant – name of a cultivated plant – picture of a pest of this plant – name of a pest – picture of a predator pest – name of a predator – picture of a predator's home – way to attract a predator to a cultivated plant.

Independent work in groups of students – students on each desk arrange as a pattern the 1st line according to the instructions of the teacher and according to the same pattern they also arrange other cards of pictures and names. After completing the work, groups present how they arranged the cards, what connections they came up with, and the teacher adjusts or adds information.

The teacher shows as an example of the activity: a picture of salad – the name of salad – a picture of slime – the name of a Spanish slug – a picture of an Indian runner (domesticated breed of mallard duck) – the name of an Indian runner – a picture of a pond.

Variation for distance learning

Go to the garden and observe life on flowers, vegetables, trees. Have you observed any insects? Try to describe any you find or you can also use the app Insect Identifier.

Which species of insects are pests on plants? Which do not harm plants, but on the contrary feed on pests? Were you able to identify any useful insects?

Students can also watch birds in the garden and take a picture of them. To identify them, they can use the mobile application BirdNET, with which they can identify the observed birds according to their call. Next, students explore on the internet what the birds feed on, where they live, where they nest, and they can guess what the birds were doing right at the place when they were watching them.

Sharing individual students' discoveries, evaluation and discussion on the topic can take place in an online lesson.

ACTIVITY DETAILS

LOCATION
Indoor

5| ECOLOGICAL PEST CONTROL

» DISCOVER
» QUESTION

TOOLS AND MATERIALS

- student worksheet W5.1: set of cards with images of plant and their pests
- teacher's page T5.1
- internet connection

PREPARATIONS

Indoor activity.

The classroom needs to be adjusted for group work.

Cards from W5.1 need to be cut according to the number of groups.

Flipchart sheets.

Group work. Each group picks one pest (from Activity 4), and the plant that is harmed by this pest. Their task is to look at the problem as biomimicry experts. When they become familiar with the organism, they suggest possible strategies for bio-inspired pest control. Each group presents their findings with help of posters.

STEP 1: To practice bio-inspired learning, students can be asked to design a couple questions that can help them to understand the organism, like 'How does... When... What...?' in relation to their pest. (For examples of questions, see T5.1.)

STEP 2: The questions will lead them to do online research about their organism, and find out about their food, shelter, daily routine, reproduction, natural enemies, defence mechanism, some special strengths or weaknesses. Based on research, they suggest different biological (or mechanical) plant protection strategies to control the pest based on natural methods. The teacher circulates around the class and prompts students with leading questions (for questions, see T5.1).

STEP 3: Each group of students makes a poster with interesting information about their plant-pest problem, and tips for ecological control. The poster should have two parts: a) analytical part – findings from research, b) measures – possible strategies for eliminating the pest. They proceed similarly to Activity 3 (Spanish slug problem).

STEP 4: Individual groups present their findings, followed by a discussion about individual discoveries and their mechanism (How is the plant protection ensured?).

STEP 5: Discussion facilitated by teacher – generalization of findings, defining principles of growing in harmony with nature, without the need to use pesticides. A possible conclusion of the teacher – these are all the principles of organic plant production. (For principles, and links to online sources, see T5.1.)

Variation for distance learning
Suggestions for small experiments in the garden (they must be given to students in a suitable season, with navigation to a suitable location – students' own gardens, public parks, school garden, etc.).

Questions see in student worksheet W5.1.
Students can share their observations during the online teaching.

LOCATION
Indoor

6| SHELTERS FOR PREDATORS

» DISCOVER
» CREATE

TOOLS AND MATERIALS

- teacher's page T6.1
- PC for creating presentations

PREPARATIONS

Indoor activity.
The classroom needs to be adjusted for group work.

RESOURCES

- Homemade aphid control: https://www.gardeningknowhow.com/plant-problems/pests/insects/homemade-aphid-control.htm

Students will implement their knowledge in the field of bio-inspired pest control to propose a measure to attract predators as "animal helpers" to the school or community garden. This measure can be inspired by a real problem in the garden, or they can choose one of the typical measures to increase biodiversity in the garden. If possible, students will implement one of the less complicated measures in the garden (e.g. a nesting box or a hedgehog home). If not, they make a video or presentation and present their projects of "shelters for predators" to each other.

Students split up in four groups. Each group chooses one measure to increase biodiversity and attract predators to the garden e.g. insect hotel, nesting box, hedgehog pile, a pond.

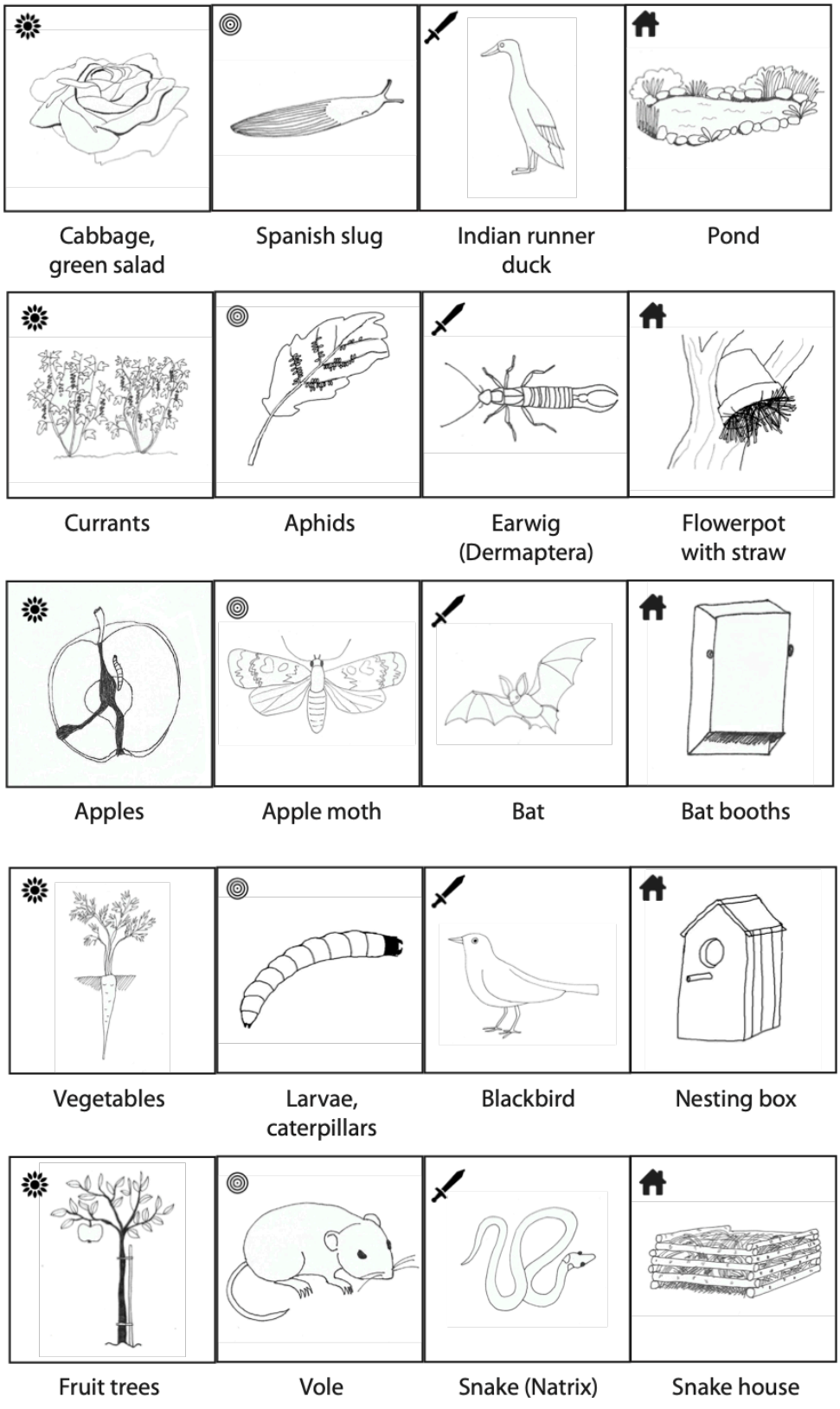
The teacher guides students in thinking which elements or criteria should be considered in order to attract predators and also make animal homes from locally available natural materials (see T6.1).

EXTENSION

Tip for a distance learning activity
You can find task for students on student worksheet W6.1.
The results of the experiment can be discussed during the online education.

T4.1 EACH PEST HAS ITS PREDATOR

Solutions



T5.1 ECOLOGICAL PEST CONTROL

STEP 1 Examples of students' question when exploring their pest:

- Where do they live?
- When are they active?
- What do they need to live?
- How do they move?
- How do they reproduce?
- What do they eat?
- How do they harm the plant?
- Which smells repel them?
- What are their enemies (whether as an adult or during his developmental stages)?

STEP 2 Leading questions to prompt students when thinking about bio-inspired pest-control:

- Is it possible to attract a natural enemy of the pest? Which one / ones? How? What is needed?
- Is it possible to use the information what repels the pest? To use the smell the pest dislikes? How?
- Is it possible to use the information what the pest likes? For example, damp or dry habitat, direct sun or shadow? How?
- Is it possible to use the information that the pest is active at certain times of the day / night? How?
- Is it possible to use information on how the pest moves? Does it have any limits that can be used in plant protection? How?

Teachers can also prompt students in the direction, for example, how to attract predators, about allelopathic relationships, and about differences in the needs of pests and plants in terms of moisture, shading or sun intensity, vegetation orientation towards the cardinal directions, etc.

Mechanical (physical) plant protection methods can be considered, together with other methods like the adaption of the varieties of cultivated plants, their location, watering method in order to eliminate pests depending on their living requirements and habits (as illustrated in Activity 3, we know that the slug loves moisture, and it is active mostly at night, therefore we will water the plants in the morning).

STEP 5 Conclusion: principles of organic plant production

- Growing in smaller areas
- Mixed cultures instead of monocultures
- Use of allelopathic relationships
- Crop rotation
- Growing of native / resistant plant varieties
- Timing of planting and harvesting
- Irrigation management
- Use of trap crops to protect main crops from pests
- Weed control – manual or mechanical

Plant protection in organic farming is based on the usage of all available preventive measures and allowed biological measures which are regulated by law as well as by certificated procedures. The aim of these measures is the maintenance of a level of pests below the control threshold. Preventive measures in organic farming are very important because of the fact that, if occurrence of some disease is detected, there are only a few permitted measures which can effectively solve the problem.

Additional information:
Best Practices for Pest Management in Organic Farm Production

T6.1 SHELTERS FOR PREDATORS

Tips

1. **Insect hotels** should be designed so that different species of predatory insects can take refuge there, e.g. solitary predatory bees.
   - Material: wood, cane, paper, cones.
     — Location: in a sunny place, e.g. on the wall of the building.
   - Wall of unfired brick: material unfired brick, flat stones, tiles and roofing laths.
     — Location: further from the fields, in a sunny place.



SHELTER FOR CERTAIN SPECIES:

Shelter for Carabus: deadwood can be used

Shelter for earwigs: clay flower pot, straw, moss, mesh with small holes, located on a tree

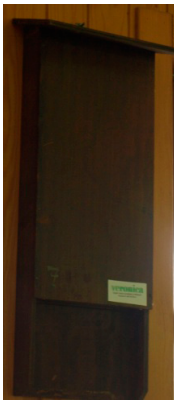

More info: Insect hotel

2. **Hedgehog home** should be designed so that this big helper of ecological gardener (eats Spanish slugs and harmful insects) finds shelter there.
   - Location: at the end of the garden or in an unused piece of the school yard.
   - Use of trimmed branches and buried dry grass.

   More info: How to build hedgehog home

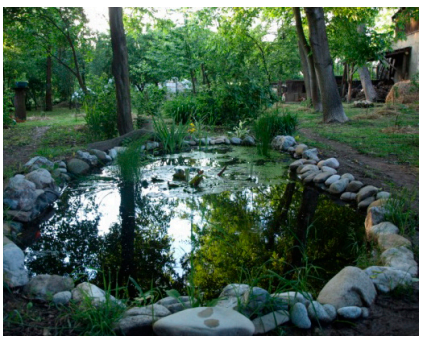
3. **Nesting boxes** should be designed so that they attract singing birds, birds of prey, respectively both for bats.
   - Should be made according to the needs of a specific type, without a landing perch under the hole, with opening roof for cleaning.

   More info: Nestling box



4. **A small pond** should be designed so that it does not dry out, it should be functional all year round – in ecological balance and attract predatory aquatic insects.
   - Important individual zones (water levels) and aquatic plants, e.g. cane, narrow leaf cattail *(Typha angustifolia)*, broadleaf arrowhead *(Sagittaria latifolia)*, so that e.g. dragonfly larvae could crawl on the stems before pupation.

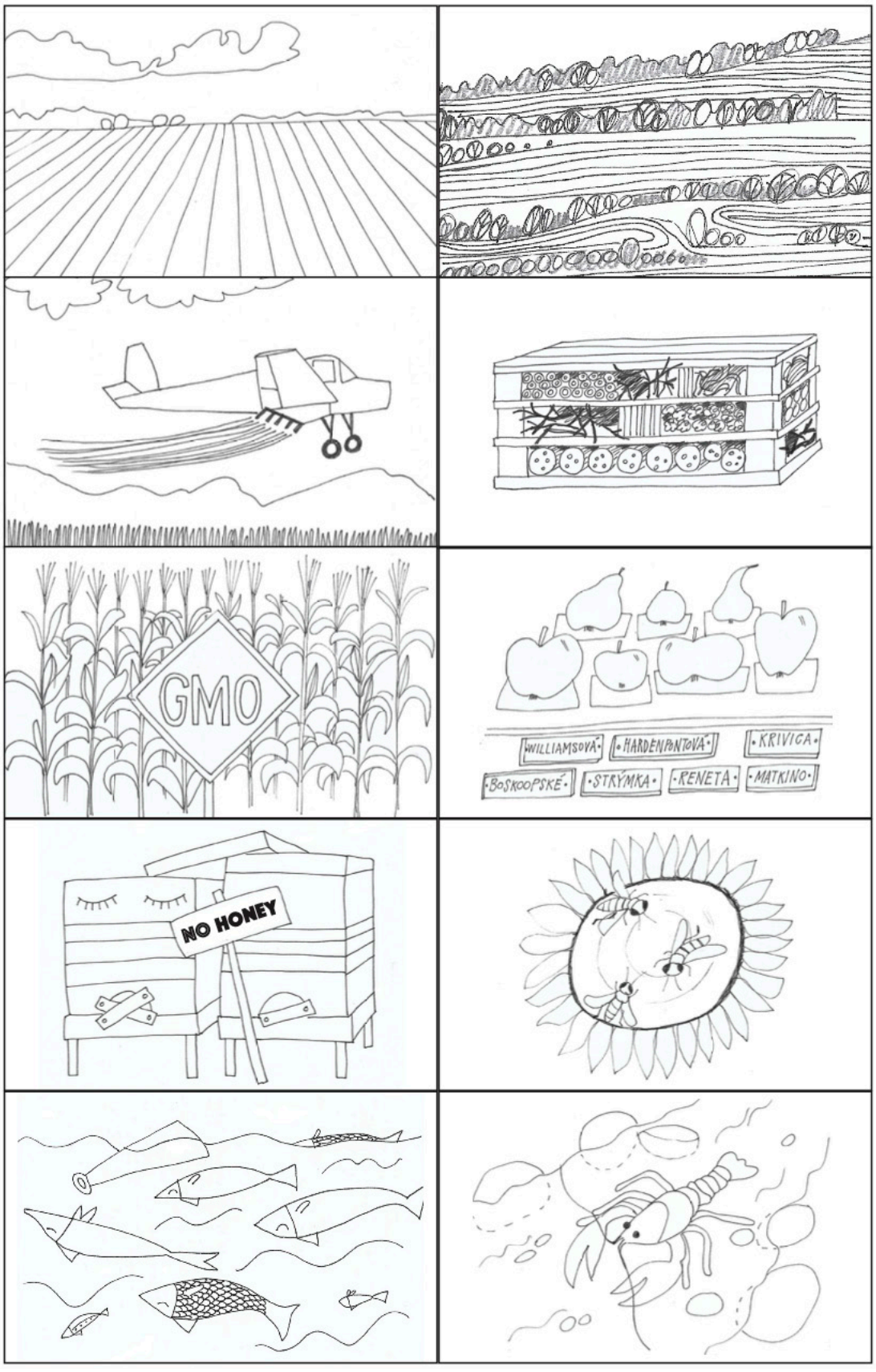
   More info: Attracting beneficial insects to your pond



Pictures on this page were made by CEA.

W2.1 TWO FACES OF AGRICULTURE: WHICH ONE IS CLOSER TO NATURE?

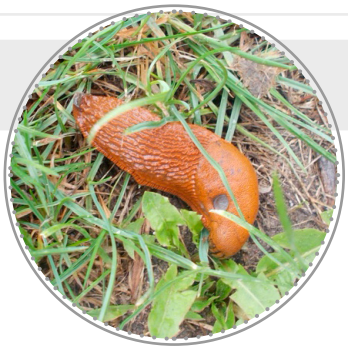
Cards

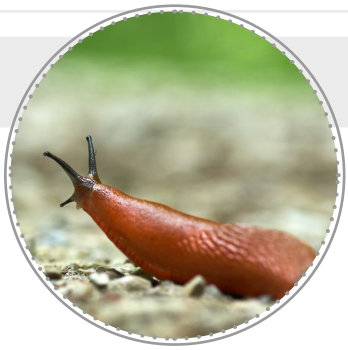


W3.1 SPANISH SLUG: NIGHTMARE OF GARDENERS

Info sheet about Spanish slug

Spanish slug





WHERE DOES IT COME FROM AND WHERE DOES IT OCCUR? It comes from the Iberian Peninsula and it is currently spreading throughout Europe with the exception of northern Scandinavia. The occurrence has also been recorded in North America.

WHAT DO THEY LOOK LIKE? A species from the *Arionidae* family, without shells, grows to a size of 8–12 cm and weighs up to 25 g. The colour can be in shades of orange and brown, sometimes with a grey or olive tinge.

WHERE DO THEY LIVE? Spanish slug likes moist, shady places where it also lays eggs. Most frequently it occurs in open habitats, in gardens, and in secondary (degraded) habitats. It is often hidden, for example, under wooden boards, in compost or composters. It goes out into the open after rain and in humid weather. It is most active at night; they can be seen during the day only in the rain. It can successfully survive dry periods, even in cracked soil as it comes from the southern areas, where they have adapted to drought.

HOW DOES IT REPRODUCE? It is a hermaphrodite. In the conditions of the Central European climate, it has one generation a year. It reproduces (copulates) in June and lays up to 400 eggs in late summer and autumn (eggs resemble small white beads, have a round shape and their average size is 4 mm). Young individuals hatch in the autumn or even in the spring.

HOW FAST DOES IT MOVE? In one night it is able to move up to 50 meters.

Photo credits: Alena Pohorencová; A curious slug on its way. Photo by Wolfgang Hasselmann on Unsplash

IN WHAT WAY IS IT HARMFUL? It is an invasive species that displaces the original species of native slugs and causes great damage in agriculture, especially in the cultivation of vegetables. The problem is that hardly any natural enemies exist.

WHAT DOES IT FEED ON? It is an omnivorous species, more aggressive than our native slugs that are attacked and eaten by the Spanish slug. In the garden, they are largely involved eating the green leaves of plants and their fruits. The most frequently attacked plants are cabbage vegetables, carrots, radishes, but also potatoes and strawberries and fallen fruits. Of the ornamental plants, Spanish slugs like tagetes. An adult can consume up to 1 kg of plant matter per season. Interesting fact: they like beer.

WHICH SMELLS REPEL THEM? Fragrant plants: garlic, fern, mustard, butterbur, persimmon, garden nasturtium, sage, thyme, hyssop, onion, chives, coriander, rosemary, fennel, dill, lavender, peony, parsley, wild thyme, marigold.

WHICH ANIMALS FEED ON SLUGS IN NATURE? Mainly hedgehogs and some birds, including many breeds of domestic ducks (especially Indian runner), some amphibians and reptiles and large species of ground beetles. Although the adult slugs do not have many enemies, the young ones and eggs have (beetles, toads, even chickens could help).
The natural parasite is the 1 mm large nematode *Phasmarhabditis hermaphrodita*.

WHAT DO GARDENERS DO TO GET RID OF THEM? They pour boiling water, spread salt, use scissors or feed them poisonous chemicals (e.g. British gardeners use some 650 billion slug pellets per year).

W3.2 SPANISH SLUG: NIGHTMARE OF GARDENERS

How to control the Spanish slug?

- Which measures do you recommend? Give 3 to 5.
- What is the function of each of the measures?
- Does it have any advantages or disadvantages?

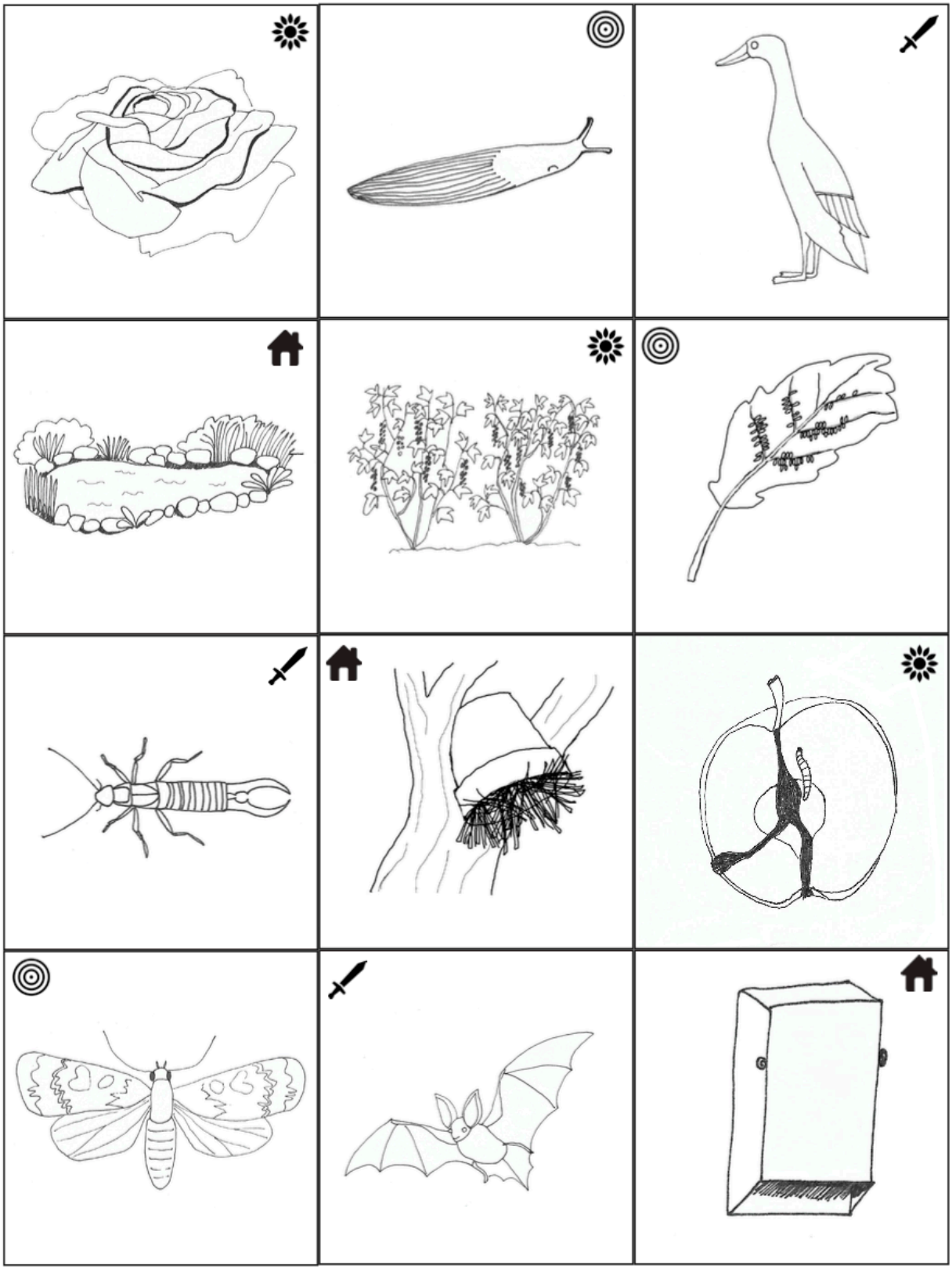
Fill in the chart:

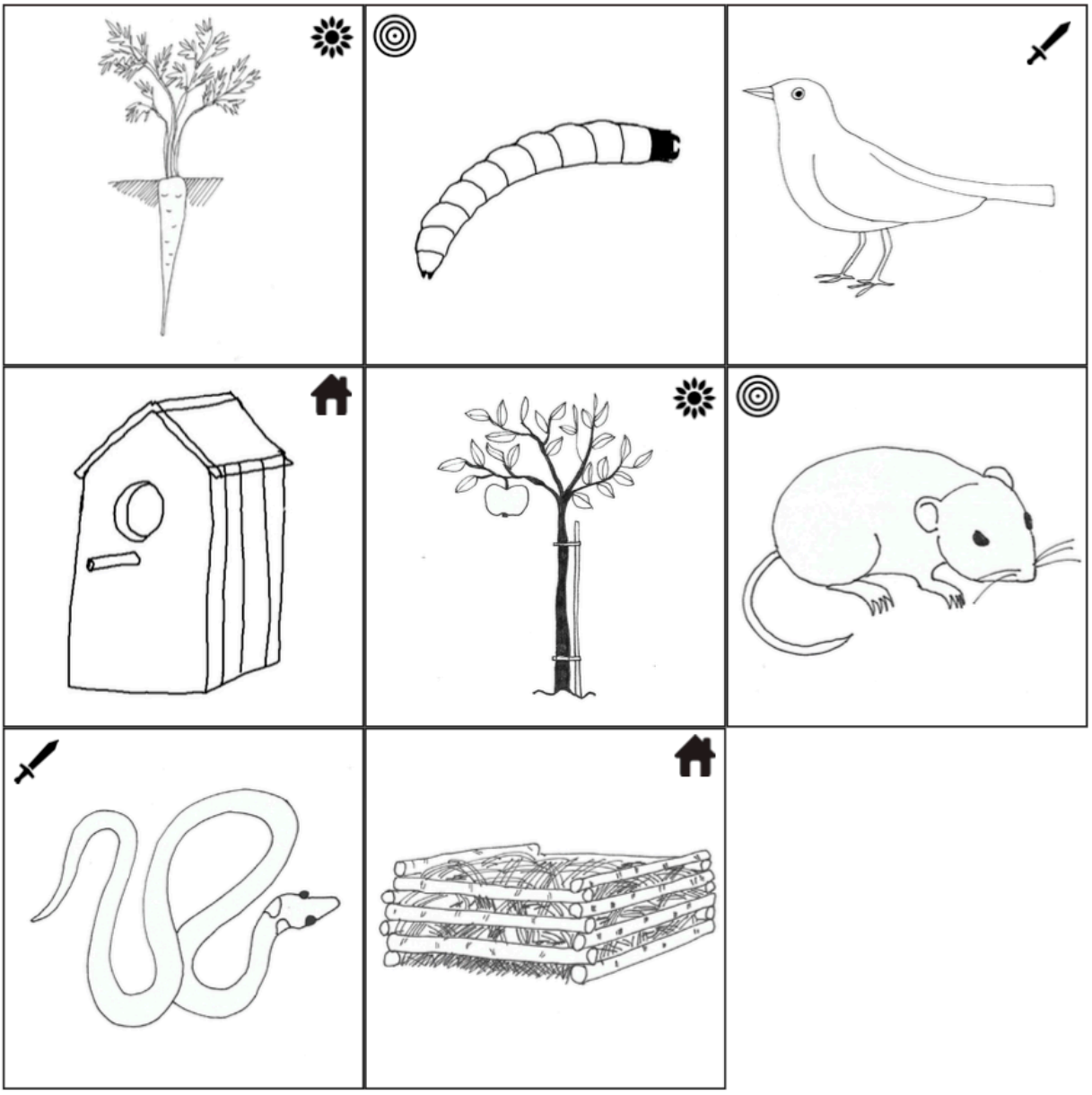
Measure	Function	Advantages or disadvantages
Beer trap	attract them, and trap and catch them (in a container) to be moved	- : too many containers with beer needed - : rather expensive + : non-toxic

Look at all the measures once again, and rank them from best to worst; from the closest to nature to the ones that cause environmental damage, unnecessary pain, are too expensive or unsustainable.

W4.1 EACH PEST HAS ITS PREDATOR

Set of cards – drawings





W4.2 EACH PEST HAS ITS PREDATOR

Set of cards - labels

CULTIVATED PLANT	PEST	NATURAL ENEMY PREDATOR OF THE PEST	ANIMAL HOME
CABBAGE, GREEN SALAD	SPANISH SLUG	INDIAN RUNNER DUCK	POND
CURRANTS	APHIDS	EARWIG *(Dermaptera)*	FLOWERPOT WITH STRAW
APPLES	APPLE MOTH	BATS	BAT BOOTH
VEGETABLES	LARVAE, CATERPILLARS	BLACKBIRD	NESTING BOX
FRUIT TREES	VOLE	SNAKE *(Natrix)*	SNAKE HOUSE

W5.1 ECOLOGICAL PEST CONTROL

Questions for distance learning – Observations in a garden

a. Observation of aphids and ladybirds

If aphids are found on flowers or useful plants in the garden, try to catch ladybugs in a matchbox (at least 10), and bring them to the aphids. Release them on plant infested with aphids and observe.

b. Observation of a bird feeder

What species of birds use the feeder? Can you identify them using a bird atlas, an internet search or the BirdNet app? What can you research about the different species of birds observed? Where do they live? Where do they nest? What do they eat?

c. Observation of ants and other insect species

Ants are predators and can eliminate many species of insects that are harmful to plants. Therefore, you will usually not find any other species of insects near the anthill. Try to verify this hypothesis in the field. Find an anthill and try to find other species of insects near it. Kneel / lie down on the grass and observe life in it or on nearby flowers, shrubs, plants. Did you observe any types of insects? Winged or wingless? Species name? (try to take a picture or draw them). At what distance from the anthill?

d. Observation of ants and aphids

Some ants have a habit of "breeding" aphids and spreading them on plants. Have you observed both aphids and ants on any plant? Why do ants do that? There is no need to kill ants because of this. We need to look for ways to prevent ants from carrying aphids on the plants we want to protect. How would you do that?

Try the following: find the "highway" of ants where they walk in large numbers and try to put various obstacles in their way. Observe their behaviour and find out which obstacle is insurmountable for them. Is it a moat for example? Or some plant that obviously doesn't smell like them? Or some sticky material? Resin? Duct tape?

Finally, try to suggest (and share your proposal in an online lesson) how to use these observations in plant protection i.e. how to prevent the movement of ants (with aphids) on these plants.

e. Potato bugs and poultry

If you have potatoes or other plants infested with potato bug (either their larvae or adult beetles) near you, collect them in a cup and go with them to your parents, grandparents, neighbours who keep poultry. Try to offer them to different types of poultry – chickens, turkeys, ducks. Which types of poultry will eat larvae or potato bugs and which will not? Can this finding be used to protect potatoes?

W6.1 SHELTERS FOR PREDATORS

Experiment for distance learning – Homemade natural sprays against aphids

If you have aphids in the garden you can make an experiment. Take a picture of an aphid-infested plant before you start the experiment. Prepare some of the sprays described below, spray them on the infested plants, and observe which of them was the most effective. Observe after the first day, and then after repeated sprays on the following 2nd –7th day. Record the results of the observations throughout the week. Take a picture after the experiment. Describe your experiment and provide the photos to illustrate the effects of the sprays. Which one was the most effective?

NETTLE SPRAY

Pour 1 litre of water on 100 g of nettle and let it infuse for 24 hours.

LAVENDER SPRAY

Mix five drops of lavender oil with 0.5 litre of water.

ONION-GARLIC SPRAY

Cut 1 onion and chop into small pieces, press 4 cloves of garlic and infuse in 2.5 litres of water for at least 12 hours.

TOBACCO SPRAY

Put 100 g of tobacco in a pot, pour 2 litres of water and bring to a boil. After cooling, strain, and add another 2 litres of water.

SOAP SPRAY

Mix 1–2 teaspoons of liquid soap (or dissolve 2–3 cm^3 of solid soap) in 4 litres of water.

Additional info about:

Homemade aphid control: https://www.gardeningknowhow.com/plant-problems/pests/insects/homemade-aphid-control.htm