ELENA

Experiential Learning and Education for Nature Awareness

Project duration: 2013 - 2016

School activities with living animals based on the Tiere **live** approach

ELENA
Educating with living animals

The trans-european project *ELENA* with partners from Georgia, Hungary, Romania and Germany aims to support a sustainable way of living and acting during a human lifetime. Through personal experiences with living animals, the awakened positive emotions can form a link between knowledge an action and motivate children to find ways to live in more harmony with nature. It was funded by the European Comission.
Find more: www.elena-project.eu

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Ants

Activities with Ants

Lifelong Learning Programme

Tiere live

Editor

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Pic. 1: Ant feeding on a honey drop (Photo: Manfred Fiedler).

Ants

Learning about ants is fun! With a little creativity there is no end to the learning opportunities which may be based around the theme of ants.

Maybe it's their amazing societal structure, feats of strength or ability to survive almost anywhere on the planet that have caused children (and many adults!) to be fascinated by ants.

"*Go to the ant, you sluggard! Consider her ways and be wise*!" (Old Testament, Prov 6:6). We're going to track this reference with the following activities.

Fundamental aims of the chapter and activities

- To reduce prejudices and evoke empathy for ants
- To recognize the role and the usefulness of ants in an ecosystem
- To evoke interest in ants as representatives of insects
- To learn more about the ants' organisational and communicational skills which can inspire innovations in technology
- To see the parallel between ant and human society

1. Technical background about ants

1.1 Classification and diversity of ants

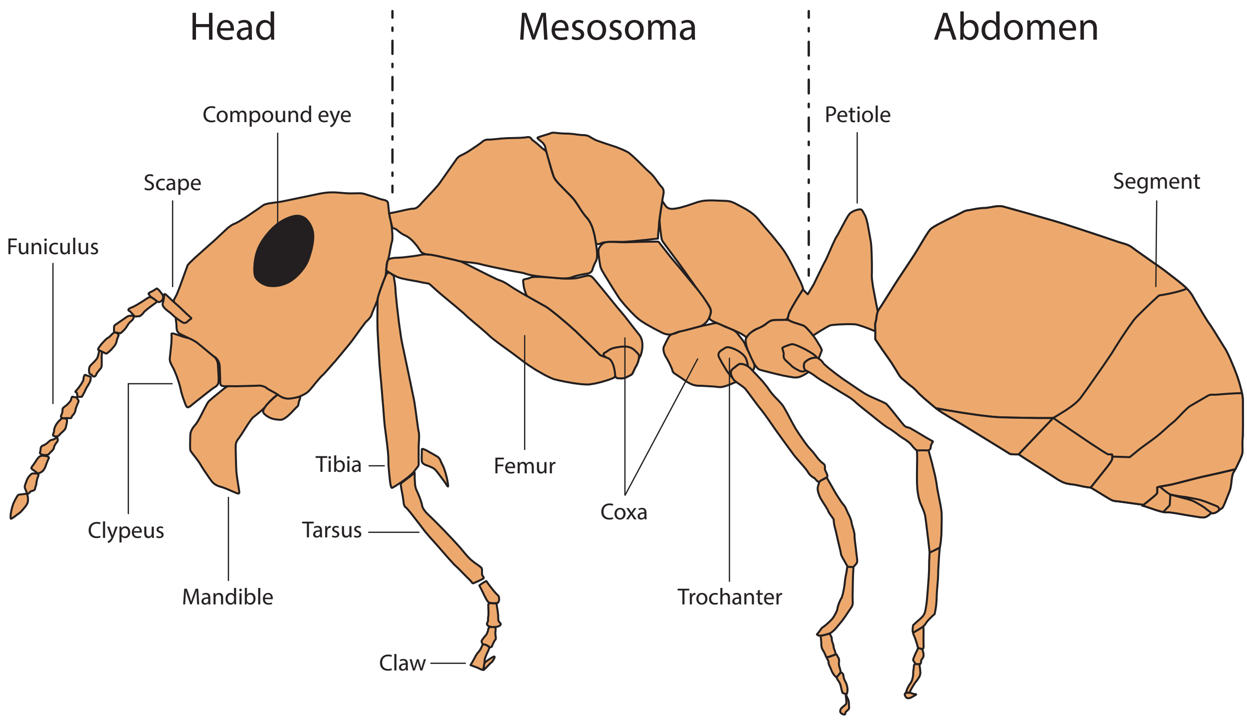
Ants are eusocial insects of the family *Formicidae* and, along with the related wasps and bees, belong to the order hymenopterous insects (*Hymenoptera*). Ants evolved from wasp-like ancestors in the mid-Cretaceous period between 110 and 130 million years ago. More than 12,500 of an estimated total of 22,000 species have been classified. They are easily identified by their elbowed antennae and the distinctive node-like structure that forms their slender waists.

Ants are one of the most successful animal families in the world. The greatest amount of ant species can be found in the tropics, while in Europe their amount is clear (about 200 species). Comparing Georgia (Genera 38, Species 173), Romania (Genera 35, Species 127), Hungary (Genera 32, Species 125) and Germany (Genera 26, Species 114), the greatest biodiversity can be found in Georgia and the lowest in Central Europe.

Ants as world record holder

- Ants are known for more than 130 million years and therefore they are the most developed insect species, e.g. the number of cells in an ant's brain is the largest of all known insect species – approx. 250,000, which means a colony of 40,000 ants will have the same size as a human brain.
- The entirety of biomass of all ants in the world covers more than half of all other insects' biomass together and according to Bert Hölldobler and Edward O. Wilson, even exceeds the human one by far.
- Ants are the most common used animals in bionics and informatics, serving as a model in different subject areas like logistics, transport research, constructing, communication and management.
- The world's fastest animal in relation to the body size is the desert ant *Cataglyphis*. Its legs have a length of four millimeters to keep its body in distance of the desert's hot ground and make it possible to cover a distance of one meter within a second. Furthermore this optimally adapted species withstand temperatures of 54°C.
- The largest construction of all animals is the nest of leave cutter ants. The hill's surface of the largest nest that was ever found had a measure of 50 squaremeters and a depth of eight meters.
- The most successful hunters worldwide are army ants. The colonies of up to two million individuals have to be subsisted and therefore they kill up to 100,000 preys a day. Due to this fact the ants keep moving constantly and build temporary bivouacs made of their own bodies instead of nests.
- The South American Bullet ant (*Paraponera clavata*) is the insect with the most painful sting in the world. For humans the sting causes violently pain which feels like burning alive and doesn´t decrease until 24 hours.
- A Siberean species hibernates in a kind of torpor at temperatures of less than -40°C.
- Loading tests with red wood ants prove that ants are able to carry weights by the factor 30 to 40 of their own body weight.

For the subsequently mentioned activities, common and widespread species are suggested. In Germany the black-grey garden ant (*Lasius niger*) out of the generic group of garden ants (*Lasius*) is the most common species in and outside settlements. *Lasius niger* is hard to differentiate from the invasively species *Lasius neglectus*, which is spreading all over Europe. In contrast to the native species it is able to build up supercolonies which can cover up to several square kilometers (for instance Budapest). The spreading process of invasive ant species can not only be observe in Europe, but all over the world. Their strategy of building up supercolonies (= cooperation of all colonies of one species in one region) illustrates a new and very successful principle which we could learn from ants.



Pic. 2: Morphology scheme of an ant (*Formicinae* type with petioles).

1.2 Morphology of ants

Ants form large colonies which are differentiated into sexual individuals who have wings and asexual individuals deprived of wings. Like other insects they show the typical body structure of head, thorax and abdomen. Nevertheless they are easily recognizable by the characteristic shape with a large head, equipped with powerful toothed mandibles and a relatively thin neck. Thorax (Mesosoma) and abdomen (Gaster) are well represented and connected by a narrow transition area (petiole) which may have flakes or may consist of two narrow segments (subfamily *Myrmicinae*).

Pic. 3: The picture demonstrates the light brown, swallow-tailed upper lip (Labrum) and dark brown head shield (Clypeus) with a keel
(Source: www.AmeisenWiki.de, Photo: Dean Epli).

Head

Arranged in front of the body, the head contains all sensitive organs. This body part, used for forward movement, should be able to receive stimuli from the environment, regardless of their nature. Both is important for the individual and colony survival. The head has a pair of antennae, which continuously moves and with which the ants touch, smell and taste. In other words, on the extension of the articulated head, there are touch receptors, and chemoreceptors, by means of the insects may generally perceive chemicals' properties. Through the smell, the fragrances of volatile substances in the air are charged, and through taste they feel the flavour of substances dissolved in water. Each antenna is composed of 11 to 13 segments and it is bent approximately in the middle part comparable with our elbow, which is another peculiarity of the ants. For some species of ants, the last segment of the antenna comprises heat detection receptors (termoreceptori) and carbon dioxide receptors for different concentrations. The eyes are similar organized to those of most insects and contain hundreds of facets (ommatidii) combined to form a unique image for the brain covering a field of view of 180°. The mesh size depends on the importance of vision in the life of ants. Thus, ants who detect prey using vision, have larger eyes, while the eyes of ants living in the dark may lessen or disappear.

Head – a cephalic capsule – also providing a basic function, that is related to feeding. Around the mouth are willing mouthparts, constituted as a unit caught chewing mouthparts (unlike species that are feed aspiring, with or without prior puncture), the largest of its elements are the mandibles. Mandibles have a role in catching and shredding prey, therefore they are large, strong, chitin composed, jagged. Besides feeding other ants, mandibles can also be used for digging, carrying and non-feed objects in battles.

Mesosoma (Thorax)

On the thorax are caught three pairs of legs (all insects are hexapod) and to wing forms two pairs of wings are added as well. Ants' legs are adapted to run- very effective in this regard; ants are extremely fast for their size. Legs ending in claws with which ants can climb even the seemingly smooth objects, and can stand even suspended. Ants sexed male and female unfertilized have two pairs of membranous wings, the first pair being greater than the second.

Abdomen (Gaster)

The terminal part of the body, the abdomen, contains most of the internal organs: heart, digestive system and glands responsible for the secretion of chemicals involved in attack or defence. Thus, some ants have a body extremity, a needle for injecting venom, while others have an opening aperture through which spreads acid (i.e. formic acid) acting to paralyze prey or for defence.

1.3 Biology, ecology and way of life

Ants have colonised almost every landmass on earth. Ants thrive in most ecosystems and may form 15–25% of the terrestrial animal biomass. Their success in so many environmental parts has been attributed to their social organisation and their ability to modify habitats, tap resources and defend themselves. Their long co-evolution with other species has led to mimetic, commensal, parasitic and mutualistic relationships.

Pic. 4: Opened nest in the ground of the black-grey garden ant (*Lasius niger*; Photo: Peter Sturm, ANL).

Ants form colonies that range in size from a few dozen predatory individuals living in small natural cavities to highly organised colonies that may occupy large territories and consist of millions of individuals. Larger colonies consist mostly of sterile, wingless females forming castes of "workers", "soldiers", or several other specialised groups. Nearly all ant colonies also have some fertile males called "drones" and one or more fertile females called "queens". The colonies are described as superorganisms because the ants appear to operate as an unified entity, collectively working together to support the colony. Further information on e.g. Wikipedia (en.wikipedia.org/ants).

Ants are something special within our native indigenous wildlife. They live in strong

Pic. 5: Great nest of conifer needles of the red wood ant (*Formica rufa*; Photo: Wolfram Adelmann, ANL).

family units of hundreds up to millions of workers and comparatively few sexual animals (mainly one queen, males seasonally). Females have an extraordinary long lifetime. According to the species workers can achieve 3–6 years and queens even 20–25 years. For a red wood ant queen an age of even 30 years was verified. Ants of our latitudes build their nests in rotten wood or under flat stones. Building nests in the ground like garden ants and nests out of conifer needles like red wood ants are more complex buildings.

Unlike simple ground nests, the impressing needle nests of red wood ants (*Formica* s. str.) are constructed much more sophisticated. Red wood ants are one of the most highly developed native ant species of our latitudes. With their needle-bunch-nests they adapted well to the colder temperate latitudes with a winter break. Supercolonies of more than 700 nests within a nest association are known. This type of nest is an ideal heat accumulator. From April till October temperatures inside the nest reach between 20 and 30°C. In addition to the solar radiation as natural heating, the rotting heat of the nest's material and the warmth of the ants' metabolism supplement it. By opening and closing the outlet-port there's an active warmth management: Like an air-conditioning the outlets get opened wide on hot days, on colder ones most of them are shut.

In winter time it is comparatively cold inside the ant nest. Due to the nest's good isolation, the temperature does never lower down to less than -10°C, which would be lethal for red wood

Pic. 6: In springtime the red ants enjoying their sunbath (Photo: Wolfram Adelmann, ANL).

ants. To heat up the nest in spring fast again, ants bring in additional heat from outside the nest: First they are taking an extensively sunbathing, heating up their dark bodies and give off the heat again within the cold nest. Due to the above-average well-tempered conifer needle nests, time for breeding sexual animals shortens to merely 5–6 weeks.

The following profiles introduce the black-grey garden ant (*Lasius niger*) as a ground-nest-building species and the red wood ant (*Formica rufa*) as conifer-needle-building species:

Ant eggs have a maximum size of a single millimetre, even with bigger

Profile black-grey garden ant (Lasius niger**)**

Pic. 7 and **8**: Black-grey garden ant (*Lasius niger*): Queen with workers and ground-nest in a meadow (Photo: Peter Sturm, ANL).

Subfamily: *Formicinae* with a squamous stem fragment between abdomen and chest.

Occurrence and spread: Wide spread and common all over Europe. Very adaptable cultural successors; in Germany the most common species in settlements. Can be found in not too dry habitats at the edge of forests and waysides as well as in settlements and weald.

Building nests: Ground-nests up to more than ten centimetres high and often around plant-stems. Therefore the not too stable construction gets more durable, as the plants conduce as columns for the building. After every raining event, collapsed corridors have to be reconstructed, which clarifies the ants' high activity upon the nest after a downpour. Put their nests under flat stones, terrace slabs and inside of deadwood as well.

Colony size: Every colony has only one single queen. Amount of workers up to 14,000, in very big nests up to 50,000. An undistinguished nest produces about 1,000 males and 200 queens per year. Hibernation without developmental stages. That means during the torpor there are only queens and workers inside the nest.

Behaviour: Getting aggressive when disturbing the nest. In summer maximum of food search at night.

Nutrition: Omnivores like every native ant. Captures smaller insects, uses honeydew of aphids and likes sweet fruits. As a rule they're having a tight symbiosis with aphids, scale insects and root louses. The ants offer protection against nutrition. They protect them against predators, overbuild near-the-surface-branches with louse colonies by using a protective covering made of soil crumbs or sand and breed root louses inside their nest. To shorten their way louses also get carried to plants nearby the nest.

Size: Queens about 8–9 mm, workers about (3–) 4 (–5) mm; male about 4–4.5 mm

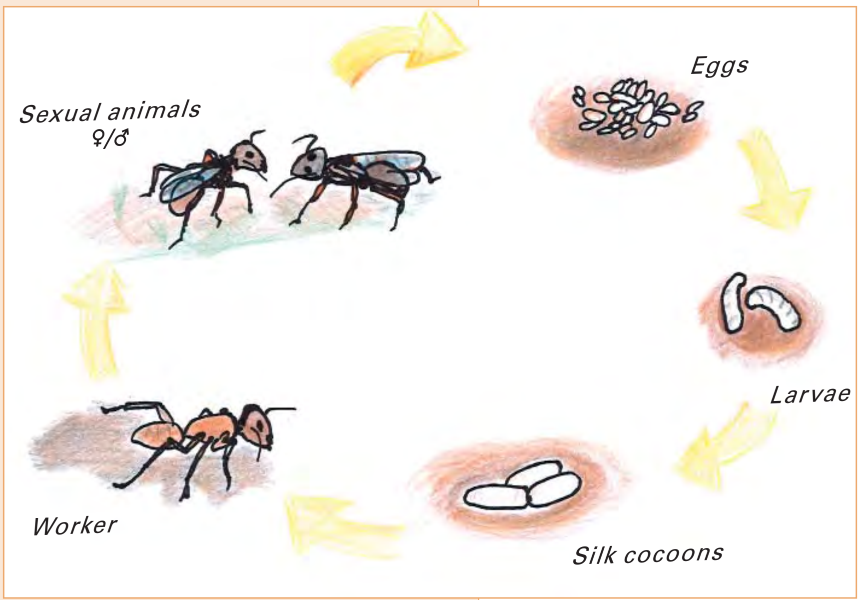
Development cycle: The life cycle consists of four stages: egg, larva, pupa and adult (=imago). The life of an ant starts with the egg stage. Ant eggs are soft, oval, small point. From the egg comes a worm-like larva, without eyes and legs. These are true metabolic machineries for which adults must carry large amounts of food. They grow quickly and moult several times during growth. When the larva is large enough it turns into a pupa, a stage of rest and reorganization, which occurs during metamorphosis, a complex process of transformation that leads to the adult stage. Pupae look more like adults than larvae, but their antennae and legs are joined to the body. At first they are white and then become more pigmented. The pupae of some species shall be enclosed in a cocoon to protect them, others remain uncovered (naked). The adult emerges from the pupa. The juvenile are white when getting output from the pupa and become darker as they grow up.

Development duration: For workers from egg to larva: about 10–15 days, from larva to pupa about 10–15 days and from pupa to hatching 10–25 days. In total 1–1.5 (sometimes up to 2) months.

Flight periods of young queens and males: July–August; normally in the afternoon. Due to the big queens, nest-entries have to be widened before. Swarming especially takes place on sticky-warm days, after a thundershower macerates the ground. This facilitates young queens digging after the flight.

Hibernation: October–March

Reproduction: Sexual animals swarm on warm midsummer days. The copulation takes place in the air. While males die shortly after it, the young queens drop their wings and found a new colony inside an enclosed, subterraneous chamber. Normally they start depositing eggs within one day. The first generation of workers normally hatches in the same year.



Pic. 9: Development lifecycle of the black-grey garden ant (*Lasius niger*; Graphics: Kristel Kerler, ANL).

Profile Red wood ant (Formica rufa**)**

Pic. 10 and **11**: Red ant (*Formica rufa*): Worker ant (left; Photo: Roland Günter) and needle nest in a forest (right; Photo: Wolfram Adelmann, ANL).

Subfamily: *Formicinae;* **Subgenus**: *Formica* sensu strictu

Occurrence and spread: In Europe their distribution area stretches from 40th to 63.5th degree northern latitudes. It is spread from Iberia to Lake Baikal and furthermore occurs from Asia Minor to Caucasus. They're settling sunlit places at the edge of deciduous and coniferous forests of all kinds as well.

Nests: Needle nests, if there are more queens, greater associations of nests. Nests with only one queen are known as well. Bunches can reach an extent and height up to three meters. The brood is carried by workers inside the storied-like corridor and chamber-system of the bunch, depending on the necessity of warmth and moisture, to avoid mildew.

Size: Queens 9–11 mm; workers 4.5–8 mm; male 9–11 mm

Flight periods of sexual animals: May–June

Behaviour: Very aggressive. Able to bite with its strong mouth tools and syringes formic acid in wounds. When disturbing the nest, little drops of formic acid can be emitted in a distance up to 10–20 centimetres. It should especially meet the predator's eyes.

Nutrition: Mainly insects, larvae, caterpillars and arachnids as well as cadavers; honeydew of aphids and scale insects and juice of trees and fruits. It contributes to the spread of plants with oily seed-appendages (elaiosomes). It eats the oily seed-appendages and carries the seeds out of the nest again. Even greater animals like a dead mouse can be carried inside the nest together.

Reproduction: In March the queens put down their big eggs inside the nest, which will develop to female sexual animals with wings. Those are therefore nourished by workers with special food, which means that in the first days after the oviposition it is opted by the hormones in the food, if a queen or a worker develops out of the egg. Shortly after the hatching, the nuptial flight of the new generation starts. Whilst mating, the female receives sperm for her whole life, which is saved in a spermathecal. The young queens either enter an existing nest or found a new one together with the help of *Serviformica*. During the oviposition females are able to fertilise the eggs on their own (development of workers) or deposits unfertilized eggs (development of male).

species. They get continually licked and insalivated by special egg-carers inside the egg-chambers, in order to prevent desiccation and ensures the essential cleanness. In the subsequent larval stages, larva guardians care for the maggot-shaped, partially translucent larvae. Depending on the species, larvae moult up to four times. The larvae guardians feed them with protein-yielding and pulpy food. After the last moult, the pupa develops. Pupae of the *Formicinae* (like *Lasius*, *Formica*, *Camponotus*) develop an additional pupa-cover (cocoon). Whereas the primarily *Myrmicinae* (like *Myrmica*) have naked pupae without any cover.

All indigenous ant species are omnivores. A special aspect about their nutrition is the “milking process” of honeydew from aphids and lice: Ants drumming upon them with the help of their antennae until they secrete a drop of this carbohydrate-rich honeydew.

Moreover preys‘ proteins are important for the brood’s growth. The proteins are mainly extracted from Arthropoda of all kind, which are mostly fresh. A colony of nest building red wood ants (*Formica* s. str.) is able to capture several millions of insects a day.

Nutrients stored in the crop, or “social stomach”, are transferred throughout a colony during mouth-to-mouth contacts (trophallaxis). There are two main kinds of liquid food transfer in ant nests: On the one hand, adults exchange liquids with larvae (they imbibe larval saliva from the brood and transfer glandular secretions, honey, and pollen to the larvae). On the other hand, the liquid is transferred between two adults. Here, donors regurgitate a drop of food from their crops while one or more receivers drink the liquid. During these mouth-to-mouth contacts, intensely antennation accompany the oral contacts.

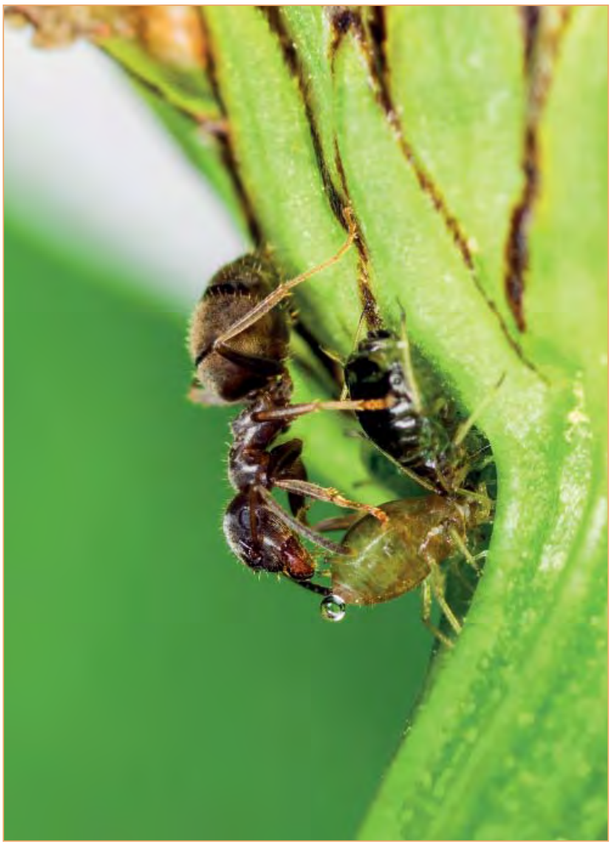
1.4 Ecological Importance / Meaning

The social way of life and nest-building require lots of energy and thus a high food demand. Ant populations therefore have an extraordinary influence on their surrounding flora and fauna. You can compare an ant-cohabitation with a densely populated city, in which nearly every house is inhabited; this makes it difficult for new arrivals to settle down.

In some regions, most rich in species you can find up to 200–300 ant nests in 100 square metres. Very tiny species can reach an even higher density. Within the indigenous soil-inhabiting insects, ants are the greatest biomass producers by far. Depending on habitat type and species, there are 30–40 kg living ants (including brood) per hectare on average. The subterraneous-living *Lasius flavus* even reaches up to 60–150 kg/ha (Seifert 2007).

Ants are behind earthworms the most intensively soil- and substrate-carriers. Their soil-biological importance consists of the fact that they have to rearrange soil material continuously for building and preserving their nests. Therefore soil layers get intermixed and aerated. The *Lasius flavus* is particularly effective with this. According to the population density, it carries 1–2 tonnes on average, in some places even up to 7 tonnes soil mass per year and hectare to build up their nest bunches.

Ants carry seed and therefore contribute the spread of several plants. Red ants deport seeds of 154 so called “ant plants”. Holding and “milking” plant lice (Trophobiose) improves their own food supply as well as the ones of other animal groups. About 250 other insects subsist on the honey dew of tree lice in the forest. Besides ants they improve the food supply of several birds, mammals (insectivores), reptiles, amphi-



Pic. 12: *Lasius niger* milking plant lice (Photo: Roland Günter).

bians, predator insects and spiders. Many passerines, like Wryneck, green woodpecker and grey-headed woodpecker, subsist mainly of ants. Especially in winter ants constitute nutritional basis for all hibernating woodpeckers. For growing up-*Tetraoninae* (e.g. wood grouse) red ants are an indispensable food supply. Ant-rich forests are bird-rich forests at the same time.

Ants are within insects the numerical greatest predators and are able to regulate the increase of other arthropods. The existence of an ant population therefore has an impact on other arthropods. Within one summer a colony of red wood ants eradicates up to 10 mio. insects, including caterpillars of numerous forest-relevant so called damaging insects and carrion.

An ant nest contributes protection and habitats for several other arthropods like spiders, millipedes, primitive insects, butterflies, beetles and so on. More than 3000 of those "ant guests" are able to appear within ant colonies. Many of the highly endangered Blue Butterfly species develop inside the ant nests and cannot survive without them.

1.5 Learning from the achievers: What can we learn from ants?

Why are ants so successful? Ants, like humans, are highly social. However, most human organizations have a top-down structure, that means, rules are passed down from above with the intention to control the dynamics at different levels and obtain specific outcomes. This often gives rise to rigid organizations that cannot easily adapt or self-regulate. A top-down structure might be successful in a static environment but it may be fatal in a dynamic environment. By contrast, ant colonies have a bottom-up structure. That means, ants react to local information rather than having rules imposed from above. This gives rise to highly adaptive societies that can easily self-regulate. Indeed, one might hypothesize that the self-organizing bottom-up structure is the generator of the proven viability of ant colonies in ever-changing environments over 100 million years. Hence learning how ant colonies work is imperative.

Swarm intelligence does not need any hierarchies or leaders. Swarms organize themselves – and therefore show intelligence, that far exceeds the individual's abilities. As a collective body ants are able to solve complex mathematical problems. That's the reason why numerous researchers try to benefit from the swarm intelligence's principle for artificial intelligence and robotics. Hence the internet bases on the "ant algorithms".

The British physician and swarm researcher Len Fisher describes this by means of the applause whilst a concert in his book "swarm intelligence". If a spectator starts clapping his or her hands, he or she can make many others clap their hands – until the whole audience is clapping. Fisher therefore comes to the conclusion: Forces that emanate from the individual are not linear. The individual therefore is able to exert a disproportionately large influence on a group. When concert-goers fall into a special rhythm while clapping, it is a spontaneous reaction of the whole audience – not of the single spectator. Researchers therein see a fundamental property of a swarm: A group of individuals solves a problem without central control, which a single group member could not cope.

It is interesting to discover the following simple and effectively principles in the following actions on your own. A good example is the food search: It obeys the simple principle of always taking the shortest route to the food source. But how achieve? Scouts explore the surrounding of the nest at first, leaving a scent, a pheromone, to mark the route. The explorer that found the shortest route to the food source, returns to the nest at first. On its way back it marked the route a second time. The other ants orientate themselves towards this double scent route to reach the food source as well. A self-amplifying effect without any complex communication technology.

2. Legal notices and handling of ants

The references on animal welfare and careful handling have to be considered especially with the very tiny ants and have to be discusse with students before starting the activities.

For teaching purposes all ant species, except the red wood ants, are allowed to be used for the described activities within the frame of animal-friendly handling.

Caution when exploring a red wood ant nest!

The risk of treading down a red wood ant in the surrounding of a nest is very high. Radially ant routes lead in all directions around the nest. Teachers and students should take care of intensively frequented routes while approaching the nest. Activities around the nest and at ant routes should only be performed with rubber boots which are greased at the upper part (e.g. with paraffin oil, petroleum jelly etc.). Otherwise the red ants directly start climbing up legs and biting into non-covered skin parts.

No lethal experiments with ants!

From the pedagogical point of view there are destructive experiments that should not be carried out. It could appear that students hit the idea of making ants of different nests fight against each other. When fighting of approximately the same magnitude, *Lasius* species start stretching their rivals if they are superior in numbers. In doing so the rival's feet are grabbed from all sides and elongated until it dies. *Myrmica* species use their thorn for defence and killing their rivals. Carpenter ants (*Camponotus* sp.) are able to bite off smaller ant species' heads with their strong mandibles within a few seconds.

All experiments which could lead to harm or death of ants have to be avoided. Those ethical topics can be discussed with the students before starting the activities. The focus is on the fundamental question of preventing experiments in which animals have to die.

The conifer nest-building **red wood ant species** of the subgenus red wood ants in a narrower sense (*Formica* s. str.) and of the subgenus *Coptoformica* are **protected by law** – Bundesartenschutzverordnung – in Germany. According to the Bundesartenschutzverordnung it is forbidden to catch, injure or kill those red ants. This shall apply equally for any forms of development. The legal protection includes the prohibition of damaging and destruction of red ant hills. This is particularly important with activities around red ant hills and routes.

Further information

Recommended reading:

Hölldobler, B. & Wilson, E. O. (1990):
The Ants. Springer Verlag; Berlin, Heidelberg.

Teaching materials

Schule in Baden-Württemberg – Landesbildungsserver Baden-Württemberg:
Haltung von Ameisen in der Schule

http://www.schule-bw.de/unterricht/faecher/biologie/material/wirbellose/insekt/ameisen/haltung.html

Freistaat Sachsen – Sachsenforst:
Das Waldameisenheft

https://www.smul.sachsen.de/sbs/download/Ameisenheft_fuer_Kinder.pdf

3. Activities

Fundamental aims of the activities

- Arouse interest for ants as highly developed social group of insects
- Familiarity with the organization of the body, lifecycle and social organization of ants
- Learning from the ants – become acquainted with organisation, behaviour and communication in sophisticated ant colonies and compare them to humans

Activities

Indoor-activities

A 1 **Ants in school – keeping and observing**

Outdoor-activities

A 2 **Testing feed preferences of ants**
A 3 **Nest observing**
A 4 **Defence instinct of wood ants**
A 5 **Why there are no traffic jams on ant streets**
A 6 **Perfume Path – How ants communicate**

Additional material

Material A 1 **How to prepare an ant farm**

Material A 2 **How to find ants**

Material A 3 **How to catch ants**

Material A 4 **How to keep ants**

Material A 5_1 **Development lifecycle and morphology of the ants** (Student's worksheet)

Material A 5_2 **Development lifecycle and morphology of the ants** (Student's verification sheet)

Material A 6_1 Teacher's sheet **"What happens if..."**

Material A 6_2 Student's worksheet **"What happens if..."**

Ants in school – Keeping and observing (Indoor Activity)

a) Let's build up an ant farm

See Additional material 1–4

Additional to the ant farm we recommend constructing an ant arena, because the observation is much easier than inside their nests. Therefore place the ant farm in a terrarium or connect your farm with a transparent tube to a bigger vessel. Fix the tube with silicon on both ends. Now it is easy to observe migrating ants during the feeding experiments. Enjoy watching the ant carrying their foods!

b) Ant farm care and achieving daily observations

As the farm foundation requires daily farm work, ants' developing and restoring activities can be noted. Materials that can be used for the construction of the nest (pine needles, straws, pieces of leaf, etc.) get placed inside the jar.
The feed consists of honey and body of insects, worms and even larvae. The feeding frequency is determined by the degree of consumption of various types of food. To guarantee a sufficient feeding, it is recommended to offer a continuous feeding source (see Additional material 4, 3. Feeding).

All observations are noted down and will be used to create a graph of activities.

Observations that can be made:

- Galleries dug daily progress (number and length)
- Delimiters special function spaces
- Accumulation of building materials
- Preferences for certain building materials
- Hatching larvae first
- Number of larvae and pupae, time of conversion
- Number of pupae and adults which changes, when the process starts and ends
- The dynamic of daily activities related to temperature and illumination
- Preference for certain food sources and dynamics of preferences

You can combine your observations with simple experiments. A list of what is applicable and which kind of tests you should avoid can be found in the Additional material (A 6 "What happens if…").

Season:

Grade level:

Development:

Aims of the activity

- Knowing the housing conditions for ants
- Handling live animals to develop responsibility
- Learning to observe ants activities
- Get familiar with the components of an ant, stages of development and adult forms
- Understanding the link between different stages of development and how they are succeeding
- Get familiar with the concept of social insects and understand how insect societies operate

Materials

- In advance procure the needed material to construct the ant farm (see Additional material A 1)
  - Two jars of different size with cover, fitting together
  - Adhesive for glass and paper
  - Soil and sand
  - Sieve and tray
  - Hammer and nail (alternatively a piece of textile and an elastic)
  - Black paper
  - Adhesive tape
- Ants (see Additional material A 2 and A 3)
- Feed for the ants (see Additional material A 4)
- You need all additional materials to implement the activity!

The ant farm should be placed at a bright site without direct sunlight.

Please note that sun positions change during the day. Solar radiation is dangerous for ants inside glass containers! Glass containers can heat up in a few minutes (greenhouse effect) that even heat tolerant ants could die.

c) Let's know ants – get familiar with the components of an ant, stages of development and adult forms

See Additional material 5_1 and 5_2

Implementation

This activity follows the farm construction and can be used for teaching ants in various stages of development taken from the farm. They are placed with a forceps into open Petri dishes for not mobile stages and covered for mobile stages.

Children received the sheet describing components of an ant and stages of development in the meantime in order to identify the biological material. Children use magnifier to observe the stages of development, will learn how they succeed, they will explain the process that takes place during the development of ants, so as to understand how to move from one stage to another.

By observing adult animals (preferably choose both winged and without wings forms, but available only few days during summer) – children follow Additional material 5_1 and recognize the ants' different body components. The teacher will explain the role of each component in the life of ants. Afterwards they compare them with other Hymenoptera (bees, bumblebees) and other insect groups, to understand the distinctive characteristics of ants. It shows children the distinction between sexual and asexual forms, they get to know the role of each caste in the life of a colony and behavioural differences between them. Afterwards students can understand the functioning of a colony, the importance of collaboration between them in the context of coexistence within a society.

At the end of the lesson, students complete their verification sheet (Additional material 5_2) indicating the name of the body of insect components, stages of development and will nominate activities within each colony by the adult form part.

Testing feed preferences of ants
(Outdoor and indoor)

Season:

Grade level:

Development:

Implementation
The entire activity is carried out in the field, but also could be placed in the ant arena (Activity 1). First you should identify an ant nest located in an area that makes possible the implementation of this activity. Genus that can be discovered easily are *Lasius*, *Serviformica* and *Myrmica*, that climb up bushes and trees. Here they fetch the honey dew of plant lice and often get back home with very swollen abdomen.

For feeding experiments greater ant species with ant streets for observing are suited well. These include red wood ants (*Formica* s. str.) with their conifer needle nests, which can be found at waysides or *Lasius fuliginosus*, which can be found in wooden parts beside rotten tree trunks.

First of all students observe the nest and identify roads used by ants. Near the road, in a radial shape towards the nest Petri dishes containing different types of feed are placed. Students make teams of two or three and track each type of food, noting the time required to identify different food sources.

Afterwards each team tracks the ants whil carrying feed and measures the time elapsed since the identification of food sources to its full transport.

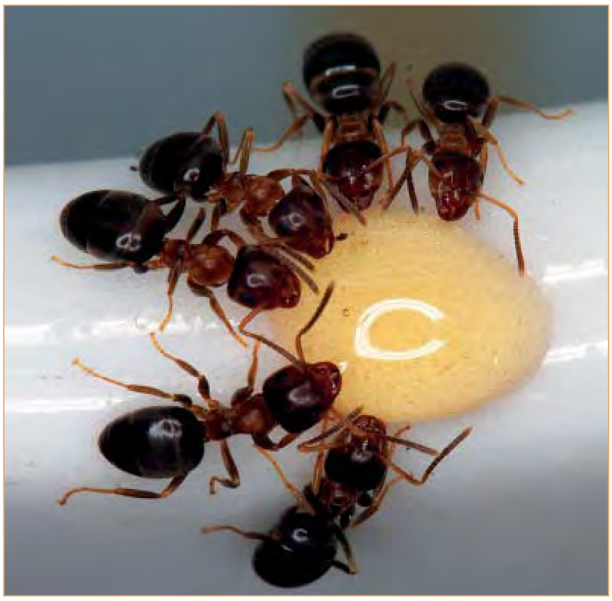
Aims of the activity
- Understanding the way used by ants to detect feed
- Knowing the importance of feed diversity during ant life stages for a colony

Materials
- Petri dishes
- Different feed types: sugar solution, honey solution (if possible with some blue food colouring), meat, cheese, seeds, the bodies of earthworms, other insects and small vertebrates
- Timer
- Additional material A 4 (Subitem 3)

Create a short experiment: Some drops of honey get mixed with water and be given into a Petri dish. You can colour the water with some blue food colour so the ants can be detected more easily. As soon as the ants find and soak up the honey solution their abdomen increases in volume. The abdome consists of many rings that enlargen by food intake. Throughout the thin membranes in between of the rings the honey solution shimmers yellow (if you've coloured it, it shimmers light blue). If you're lucky you can observe ants feeding other ants mouth-to-mouth.

Create a short experiment by fixing the feed (piece of meat) to the ground (use needles): Observe the recruiting system of the ants. The work location is repeated with different feed containing greater distance off the paths that ants use to access.

Take into account that the amount of solid or liquid food to be tested has to be equivalent, and as a second, the distance from nest to food sources have to be equivalent, too. The results obtained by each team is centralized and discussed in class.



Pic. 13: Brown garden ant (*Lasius brunneus*) feeding on a honey drop (Photo: Wolfram Adelmann, ANL).

Technical information

A differentiated division of work is the qualification for an ant nest to run efficiently. But this depends on a fair distribution of feed which ants solve by using a sophisticated procedure of food exchange (Trophallaxis). Ants which are not able to leave the nest are begging other ants for sharing their food with them. Commonly begging illustrates a lack of food for the field service that makes them search more often. For this purpose ants got a social stomach (crop) which is used for storing food. The field service ant stores the feed inside its crop to give the substance to its nestmates. An ant begging for food therefore drums upon the donators head with the help of its antennae and touches its mouth with its forelegs. Those movements against the lips (Labium) lead to choking of food. A drop of the crop's substance is applied on the lip, so the begging ant can receive it. Only a small amount of personal need is taken by the donator for its own stomach and gets digested.

Nest observing

Implementation

Identify a nest, which students can pursue and identify routes of moving ants. It aims at the starting point and ending of each route; determining the length of these routes.

Afterwards the observations are transferred into a map that marks the nest, routes and other topographic features (paths, trees, bushes, etc.). Identify and track an ant for 10 minutes that can be observed easily (an ant carrying a recognizable object) and record all its actions. Organize in groups, students taking notes on each route, ants and their cargoes. They should note down the type of items carried, the number of objects in each category and transporting direction (towards the nest or away from it).

Install a string on two sticks over the most important routes identified and for 1 min. all ants passing the string beneath are counted. It then reports the value obtained for different time (1 hour or more).

All observations are concluded and discussed in class. Make a list of activities carried out within the anthill of the comments made.

Season:

Grade level:

Development:

Aim of the activity

- Establishing the activities carried out in a nest following materials being transported worker ants

Materials

- Paper and pencils for drawing ant paths getting out and into the nest
- Spreadsheet
- Timer
- Rope

Combining with other activities: You can use the list of short experiments **"What happens if..."** (Additional material A 6_2) to observe different kinds of behaviour.

Defence instinct of wood ants

Season:

Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug

Grade level:

Development:

Implementation

Identify a nest of red wood ants (*Formica rufa* s. str.). A colony of various small hills is more suitable for group work than one great hill. Nests that can be reached easily next to a wayside or a forester's way are on advantage. Hinds of a forester can be helpful.

The season most suited to implement this activity is May–June. At this time there are many butterfly caterpillars and tree lice as well. The activity can be carried out till September, afterwards the activity of ants decreases straightly. A warm and sunny day with the animals' high activity is most suitable. **Don't carry out the activity whilst rainy or cold weather.** The red wood ants' conifer nests can be found near conifers and at sunny waysides. **Don't step on ant streets while approaching the nest.**

Never approach a nest without wellingtons. Draw a ring of paraffin oil or vaseline at the top of them to avoid ants running up legs and biting. Without this preparation this activity is doomed to fail due to the loads of ants running up the student's legs.

Aim of the activity

- Understanding defence mechanisms of ants

Materials

- Additional material A 2 **"How to find ants"**
- Blue flowering plant
- Painted egg
- Litmus paper
- Black cardboard

Experiment 1

Use a black cardboard for background to view jets leaving the ants' abdomen. Register with a camera. Move a blue flowering plant nearly above a part of the nest with many ants. If there is no change in colour, the ants are not aggressive enough. If so, slightly stripe the flower or Litmus Paper over the nest's surface. **This can be used also in chemistry class.**

Result

The workers turn their abdomen forward and syringe tiny drops of formic acid against the allegedly predator. This can be observed against a dark background simply with your own eyes. The flower colour after spraying formic acid will change in the contact areas bleaching – red sprinkles appear on the flower. Boiled eggs that were previously coloured with beetroot juice, or litmus paper, which will turn red on contact points can be used as well.

A paper tissue can be scented and stir over. Ants reaction is the same, to spread formic acid against intruders. Napkin smell following this activity will change. You can also ask single students to move their hands directly over the nest. Due to the formic acid an unpleasant pungent smell appears on the hand.

Pic. 14: Worker of red ant (*Formica rufa*) in a typical self-defencing position. The acid drop is visible as a white dot (Photo: Wolfram Adelmann, ANL).

Experiment 2

Take the same flower or a little flexible branch to strike over the nest's surface with many workers and draw a little circle. Some ants intentionally get touched or pushed aside. The flower/branch is put upon the nest due to ants directly biting at it.

Students now should observe how far and intensively the excitement carries on.

- **Carry out this experiment as careful as possible to avoid any harm for the ants!**
- **Strong disturbance by opening the nest must be avoided!** Only in this case the whole nest would react and attack the great predator (naturally woodpeckers or wild boars) in common.

Result

Ants directly get into alertness when they are touched, hardly increase their running activity and are highly aggressive. They grab everything that moves. But the excitement does not spread uncontrolled throughout the whole nest, only few parts in the sector of the disturbance get into alertness. The rest of the colony carries on like always.

Experiment 3
Observing lesson for students at red wood ant streets

Identify a narrow but distinctive ant street. A distance of about 2 meters from the nest is favourable, because the chance to step on ants is much lower.

- Velocity of ants (strongly depends on temperature: At warmth faster, under 15°C slow)
- What happens when interrupting the scent track? Draw a little ditch (not too deep) with the help of a little branch crosswise to the ant street. Observation: Due to the interruption of the scent track, ants stop moving or run around. Apparently they are irritated and don't know how to go on. But soon the first ant crosses the ditch and puts down a new scent track.
- What do red wood ants transport on their ant streets? Grab all the transported goods of the ants with a forceps for 5 minutes and collect it. Study the goods with a magnifier and make a chart of your results.

Feeding experiments

- Put a moistured piece of sugar cube (diameter 3mm) on the ant street
- Place a watch crystal beside an ant street and observe the changes of the drinking ants. With a little luck you are able to observe how one of the ants, returning to their nests, will be begged from other ants and will feed them.

Carry out Activity 5 **"Collective intelligence** or **Why there are no traffic jams upon ant streets".**

a) Collective intelligence or Why there are no traffic jams upon ant streets

Season:

Grade level:

Development:

Aims of the activity

- Learning about collective intelligence
- Reflecting own behaviour within public traffic

Materials

- Additional material A 2 **"How to find ants"**

Implementation

If there's time, this activity can be combined with Activity 4 "Defence instinct of wood ants".

Red wood ants' streets (*Formica* s. str.) can be observed well. Their conifer nests can be found in the surrounding of conifers and sunny waysides. From the nest hill there are always several streets leading in the surroundings. Identify a street of a distance more than 2 meters from the nest.

The shiny black wood ant (*Lasius fuliginosus*) also runs in dense lines and builds its nest inside rotten trunks. There are always dense lines running up trees or across forest ways. A sunny warm day with animals' high activity is ideal for this activity.

Observing exercise: Why are there no traffic jams upon ant streets? Students get in little groups to study the streets on their own and report about their observations.

Technical information: Avoiding traffic jams like ants

Holidays have just begun and again there's a great traffic jam at the highway to Salzburg. At the same time upon the ant street: Perfectly floading crawling, multitrack, in opposite directions – without worth mentioning accidents or delays. What are ants able to do which mankind is not?

There are different laws upon ant streets. Those insects do not act self-serving but cooperatively. Every single ant improves the chance of survival for the whole colony, by contributing an optimal velocity of all road users. The dense roads of red ants have a pass quote of more than 100 ants per minute. A french team of researchers even found out, that ant streets get more efficient the more dense they get – hardly conceivable upon highways of human. The insects' advantage: They don't move around isolated in junkers but communicate via tangency and especially with chemical signals. With the help of pheromones they do not only mark the best way to food sources but also exchange about their amount. Furthermore they even communicate with ants which are running on the contraflow.

An experiment of japanese researchers shows how different speeds lead to bottlenecks on streets. The experimental setup: 22 car drivers drive upon a route of 230m in a circle. They got the task to keep the same velocity. But only a few moments later some of them already are too fast or too slow. The first one has to slow down, than the man behind – that leads to a ripple of congestion that goes on. If all drivers would behave just the same, there would be no congestion. It's a myth that driving faster would avoid a traffic jam. At a highway the originator drives ahead away from the congestion, while the drivers behind wonder about the stagnation "out of nothing". This effect especially appears when the street is working to capacity. In fact highways have the highest flow-rate at a speed of 60–80 km/h.

Researchers from Belgium and France found out that there are no congestions with ants – no matter how many of them are on the road. To study the ants' behaviour the researchers built two different testing tracks for two different groups of ants. The first track offered a wide bridge between nest and food source while at the second one there was only a narrow one available. Not more than two ants could pass this second way at the same time. The result was that both groups nearly brought the same amount of food to their nests.

The group of ants that had to run the narrow way demonstrated an interesting behaviour: New arriving insects were waiting in common until the contraflow passed the narrow bridge. Afterwards the patient group started running commonly, while a throng developed at the other side of the bridge again. The researchers could not register any collisions.

Ants mark the way from a food source to their nest with pheromones. Therefore colony mates get lured to use the same way for food supply. British researcher could find out how ants avoid congestions: If the amount of ants increases so that they hinder each other, the ants emit less pheromones. Thus the path gets less attractive and the traffic volume decreases. Such a regulation in kind of negative feedback raises the efficiency of food supply for the nest, researchers of the "Journal of the Royal Society Interface" explained.

Results of the observation exercise

Ants move around according to temperature (colder – more slowly, warmer – faster) and a nearly equal velocity. Therefore they keep a small but sufficient distance so that little changes of speed do not lead to halt and thus not to congestion. By avoiding traffic jams the optimal flow-rate can be reached.

Discussion for students: Why do humans not achieve avoiding traffic jams? Aren't we more intelligent?

Humans often do not act rational but egoistic. To leave a very space to the person in front seems to be a waste of space that has to be erased directly. That means at full breaking traffic jam! "The traffic jam" are all the other cars, the own one is seen absolutely neutral and uninvolved in the congestion.

Speeders that jostle into a pinch gap by lane change, get a personal contentment of overtaking many cars and feel better than all the others behind. Thus the subjective perception is completely different from the collective one. Drives that are too fast will meet a slower car in front of them, he or she has to slow down significantly which can engage a traffic jam. If the cars behind have to slow down as well, the subsequent traffic is interrupted.

Ant rules to avoid traffic jams

- Do not overtake! Do not change lanes when it goes on (same velocity for everyone).
- Keep a sufficient distance to the person in front.

Thoughts of a speeder

"If everyone would continuously be driving 250 km/h there would be no problem. As it is only me driving 250 km/h, I have to slow down in front of slower cars again and again. The ones behind me which I have just overtaken have to slow down as well."

Valuation

A downright stupid way of thinking, because the speeder thinks that he or she is the only person on the highway.

Heavy and greater vehicles (according to ants workers that carry food towards the nest) are not able to drive that fast. Furthermore every car that drives faster needs a greater safety margin and therefore more space on the highway. They force vehicles to evasion which therefore reeve into other cars' safety distance. That leads to a common slow-down of the traffic flow. The risk for accidents increases blatantly.

b) Traffic jam game – Fire test

It is a game, where students have to leave a room as fast as possible under different framing conditions.

Teacher role: Time and note the required time the whole group needed to leave the room. After each round ask the students, who has been a) overturned, b) pushed/touched by his backer or who maybe c) felt uncomfortable with the situation (note the numbers).

Attention: If there is any risk students can be hurt by fast leaving the room, relocate the whole activity to outdoor and create a "virtual door" using two school bags as door frame.

Play the following cases

Case 1: Tell the students that there is fire in the school and they have to leave the room/classroom, it's important that they have to keep calm and leave the place in an orderly manner, no pushing, elbowing, nobody take over the others, just nice and easy (like the ants everyone keeping the same speed).

Case 2: Those who have a key/tissue etc. in his/her pocket are aggressive and want to leave the room the fastest.

Case 3: Appoint 3–4 students who are slower than the others for some reason e.g. one has a broken leg, or she is a lame etc. plus there are still those who are aggressive.

Season:

Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug

Grade level:

Development:

Aims of the activity

- Learning about collective intelligence
- Reflecting own behaviour

Materials

- Stop watch/Timer (e.g. inside a mobile phone)
- One note book, pencil

- **Curriculum connection:** biology, languages, social sciences, ethics, religion
- **Competence:** curiosity
- **Type of work:** if too many students arrange them in teams
- **Time:** 20 minutes

Case 4: Play Case 3 again, but the 3–4 disabled people get the chance to move a little bit earlier than the others.

Case 5: Complicate the movements by placing some obstacles (chairs/ school bags) on the way out – keep the slowly moving and the aggressive students.

After all compare the results and see which was the most efficient way to get out (ask for speed and for the risk, that somebody could be hurt!), discuss experiences etc.

Conclusion: The ant movement is maybe not the fastest, but the safest way to get out of a burning school!

Perfume Path – How ants communicate

Implementation – Create a labyrinth in the school

1. Take 3–4 perfume scents and make a trail with each of them throughout the building.
2. Let each of your students choose a scent.
3. Make them follow their chosen scent.
4. After a certain time of 15 minutes discuss with the students if they were able to follow their chosen scent or not.
5. Discuss with your pupils that this is exactly what ants do.

Technical information

Chemical signals, so called pheromones, are as much important for ants to communicate, like a modern mobile phone for humans. Pheromones are mixtures of different hydrocarbon substances, produced in special glands in the ants. Ants are marking their streets with pheromones. If an ant detects a piece of food, she will mark their whole way back to nest with her pheromones. Other ants are able to follow this "perfume" path and marking on their way back in the same manner. The more ants using the same path, the more intensive positive scent covers the path.

But some scents could chase ants away: Scents like essential oils from herbs, lavender or lavender flowers, ferns or coffee powder.

Season:

Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug

Grade level:

Development:

Aim of the activity

- To experience how ants communicate

Materials

- 3–4 bottles of different perfumes, sprays

- **Curriculum connection:** biology, chemistry
- **Competence:** curiosity
- **Type of work:** if too many students arrange them in teams
- **Time:** 25 minutes

How to prepare an ant farm

Preparing the jars

The smaller, closed jar is fixed at the bottom inside the larger one with an adhesive (you can use modelling clay), so that an even space is delimited between the two jars in which the ants can act later.

Pic. 15: Two sizes of glasses were needed, the smaller version with cap (All photos: Mihaela Antofie, ULBS).

Pic. 16: Estimate the distances between top and sides.

Pic. 17: View from the bottom: A minimal off-centred position of the inner glass is ideal for the ants to construct their nest.

Materialien

- Two jars of different size with cover, fitting together (Picture 13 and 14)
- Adhesive (modelling clay)
- Soil and sand
- Sieve and tray
- Hammer and nail (alternatively a piece of textile and an elastic)
- Black paper (in cardboard box quality)
- Adhesive tape

Preparing the soil

It is recommended to use a mixture of soil and sand in order to avoid a very dense soil and to facilitate the gallery system construction. For the soil colour it is best to choose one in contrast with the colour of the ants, that makes it easier to observe. You can also use different soil colours to generate layers which will mix while the ants dig their galleries. Advisable is an under most layer of roughly material for drainage. You can use clay granules (like for plant pots) or little limestone which improve the nest’s ventilation.

The soils and sands chosen get sieved into the tray.

The space between the two jars is filled with soil, only a space of a few centimetres has to remain on the top allowing to feed the ants (see Pictures 19 and 20 and Additional material 3 and 4).

Pic. 18: Sieve the filling: A spout easier the way of filling soil or sand in the jar.


Pic. 19 and **20:** Fill the jar with a sand/soil mixture. Right hand: Estimate the filling highs. Take care to keep enough space for feeding and water supply.

Pic. 21: Close the top with a breathable material.

Preparing the ventilation and light protection

The cover of the large jar has to be perforated using a hammer and nails to allow the air to circulate, alternatively you can replace the cover with a piece of textile material and an elastic.

During the observation-free time, ensure to keep the ant farm dark. Therefore you should prepare a light protection with a shade paper. Take a rectangular black paper in a cardboard quality and measure the size: Take the same size of the final filling as heights as and a little bit bigger than the scope of the jar as wide. Fix the ends with glue or adhesive tape. Please, don´t fix the shell to the jar, it should be removable for observation.


Pic. 22 and **23:** Preparing the shade paper: The shade shell should be easily removable from the ant farm.

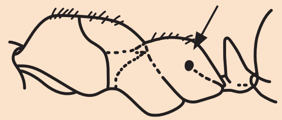
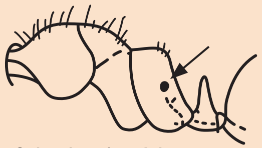
How to find ants?
(On trees and shrubs)

Where to find?	How to determine?	Picture	Species name
In wooden parts of trees or rotten deadwood.	**Very big: 8–9 mm size, black or black and red coloured; solitary moving individuals** To be distinguished from the Forest ant cause of her regular and slightly curved back.		Carpenter ant (*Camponotus*)
Anthills of collected **needles** (spruce, pine tree). On **forest edges** and **sparse forests.**	**Black and red** coloured, size 6–7 mm Two notable humpbacks. Often moving in lines (ant streets).		Wood ant (*Formica*) **Neither suitable nor allowed for keeping! In Germany this species is strictly protected by environmental law.**
In wooden parts beside **rotten tree trunks**. Building (like wasps) carton nests.	**Dark black, with shine like polished.** Size: 4–6 mm. Moving in lines **(ant streets)**		Jet black ant (*Lasius fuliginosus*)

On the reverse page: In open spaces and gardens

How to find ants?

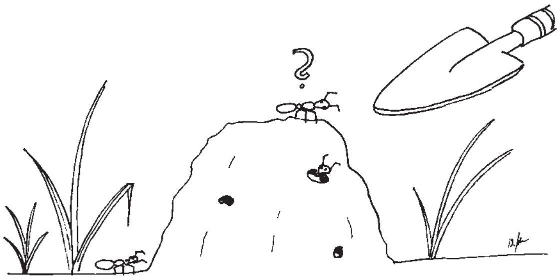
(In Open spaces and gardens)

Where to find?	How to determine?	Picture	Species name
Soil nest with **dried blades of grass** in **gardens** and **open space**, sometimes **under stones/terrace tiles**. Very common in urban areas and rural communities.	**Black-grey**, size: 5–6 mm 		Dark grey slave ant (*Serviformica*)
Soil nest in **gardens** and **open space**, sometimes under **stones/terrace tiles**. Very common in urban areas and rural communities.	Obvious **red coloured** with **two nodes** between breast part and abdomen. Size: 4–5 mm, surface of the body with notable structures.		Red ant (*Myrmica*) **Attention: The species is able to sting!**
Soil nest in **gardens** and **open space**, sometimes under **stones/terrace tiles**. Very common in urban areas and rural communities.	**Black-grey**, size: 3–4 mm  Profile of the back with steep and oblong sloping till the petiolus (in contrary to the genus *Formica* or *Serviformica*).		Black garden ant group (*Lasius* sensu stricto)
Soil nest in **gardens** and **open space**, sometimes under **stones/terrace tiles**. Very common in urban areas and rural communities.	**Light yellow or ochre, homogenous coloured, exclusively living subterranean.** Size: 3–4 mm		Yellow meadow ant (*Chtonolasius*) Yellow subterranean ant (*Cautolasius*)

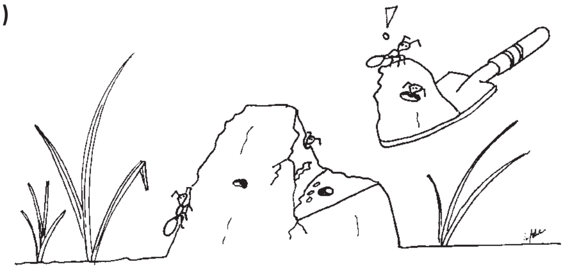
On the reverse page: On trees and shrubs

How to catch ants

1)



2)



Pic. 24 and **25**: How to remove small parts of an ant nest with a hand-shovel (Graphics: Wolfram Adelmann, ANL).

When you catch a part of a colony

Take a box including its cover with you. After you found a suitable earth nest, extract a piece of it, using a little hand-shovel or big spoon and fill it into the prepared box. Ants running around the hand-shovel get blown or wiped into the opened nest. For transporting it is no problem to hermetically seal the box but do not keep them inside for more than one day.

The chance to find the single queen of *Lasius niger* is very low. Depending on the season, eggs and larvae can be found, from summer on also the large brown-coloured pupae of queens in the outer part of the nest. In the nest's dome temperatures of about 35°C and more can be reached (earthnest) or under stones with temperatures of 20°C a few centimetres deeper. Further developed pupae get carried into the warmest parts of the nest, the more sensitive eggs respectively younger larvae get stored in cooler parts of the nest. Depending on how deep you enter the nest, different development states can be expected.

Pic. 26: From July–August you can find winged sexual animals inside earthnests of *Lasius niger* just before their nuptial flight. In the picture you can see the larger winged queens, the significantly smaller workers and the white larvae (Photo: Alfred Buschinger).

When you catch only one ant

The method for catching a small ant like *Lasius* or *Myrmica*: Lick the index finger and cover it with a large amount of saliva. Press the back of an ant lightly and careful. Pick it up on the finger with the saliva.

How to keep ants

1. Introducing the ants for our farm

The caught ants and eggs get introduced into the jar and gets covered (see Additional material 1). Afterwards a cuff made of black paper gets cut out. The measures should be as high to cover the whole soil inside the jar and a little wider than the circumference of the jar. Put the cuff around it and fix it with little stripes of adhesive tape, but only upon the paper, not the jar itself. That is to pull down the cuff more easily when you want to observe the ants.

Pic. 27: Top view: Jar filled with ants. The space to feed the ants can be seen clearly (Photo: Mihaela Antofie, ULBS).

2. Moisture

Ants living in very dry soil only have rather modest demands according to moisture. Species of normal garden soil need continuously slightly moist soil.

Therefore the soil should never dry out completely and no accumulation moistness may develop!

Keep the soil slightly moist with spray bottle or pipette, but not wet. Alternatively the soil can be casted slightly every 3–4 days (if the fruits for feeding are juicy enough and the room's temperature is not too high).

If there's enough space, you can offer a little water source: If ants continuously linger around the trough, it is an important indicator for too less moisture.

3. Feeding

The ants get feed at least 1–2 times per week. Before feeding you have to remove all old food remains to avoid mould growth, but not later than 2–3 days!

Adult animals especially need carbohydrates. Ants like little pieces of sweet fruit (best would be apple, pear or grape). They love sweet honey and sugar cubes, damped with some water. The feeding of carbohydrates in moistly or liquid mode (e.g. honeywater) is necessary. The honeywater (60% honey + 40% water) has to be well dissolved and not stand too long. Honey can be fed pure as well.

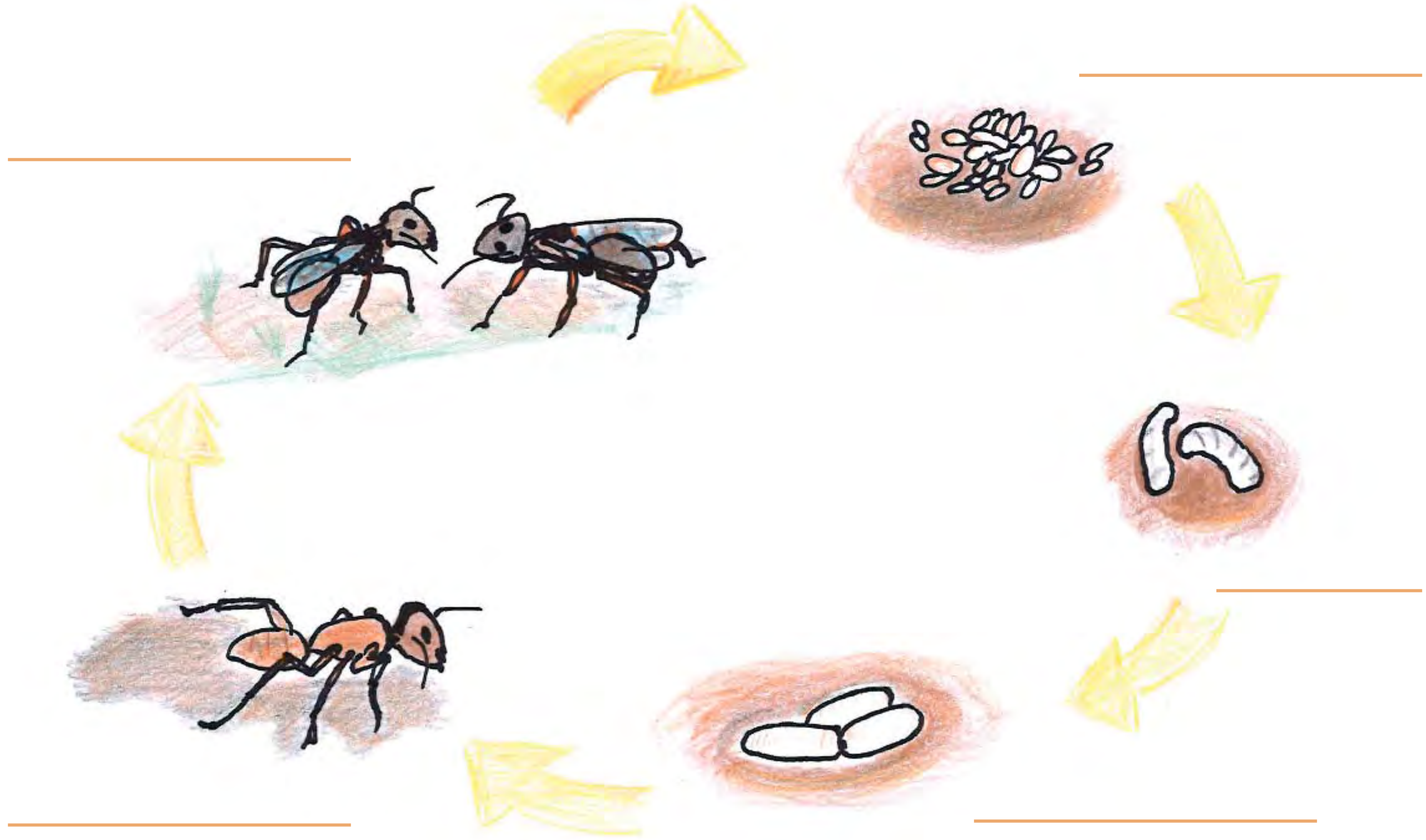
Protein-containing nutrition is important for the growth of the brood. Small pieces of cheese, meat, insects (flees, midges, grasshoppers). Especially for smaller species like *Lasius* it is difficult to bite through the hard chitin cover. Cutting those insects makes it easier for ants to eat them. Alternatively for insects: cat/dog food, fish or other meat.

Never use dry, roasted, spiced or salted meat! Bought mealworms, flee maggots or crickets constitute a risk of parasites like mites. If you want to use them still, overbrew them with some hot water.

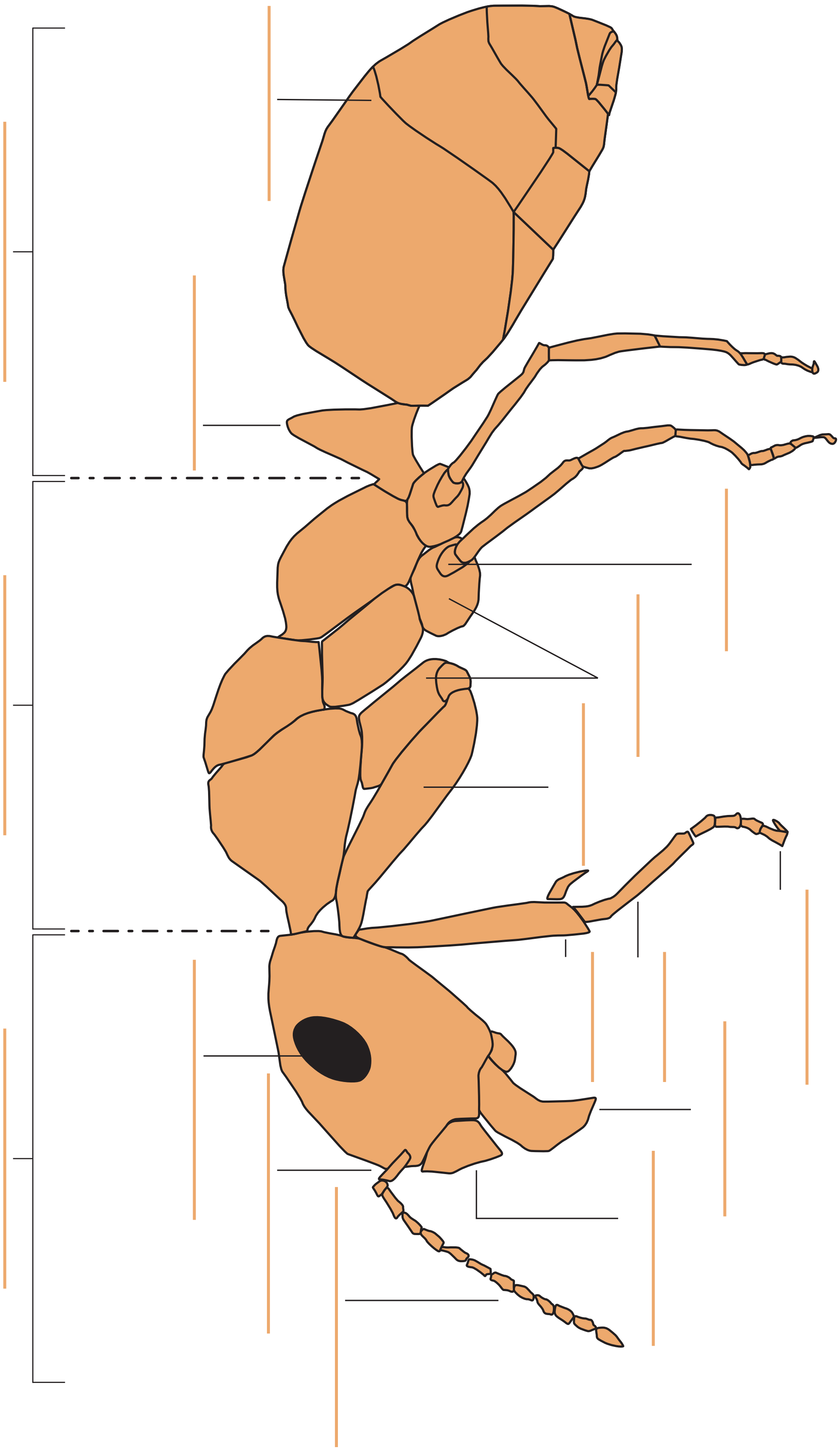
4. Releasing the ants

The ants can be caught at the earliest at the end of April. Releasing them should take place next to the same nest as they were taken from. At the latest in October.

Development lifecycle and morphology of the ants (Student's verification sheet)



Development lifecycle of the ant (Graphics: Kristel Kerler, ANL): Please, fill in the missing labels.



Morphology scheme of an ant (*Formicinae* type with petioles): Please, fill in the missing labels.

“What happens if...” (Teacher’s sheet)

For indoor activities with ant arena or for outdoor observation!

You should avoid the following experiments, because this causes the ants’ death or demonstrates a non-respectful behaviour against animals!

The following list is only for theoretical use to discuss with the students, because it contains experiments which could harm or danger ants. Those Experiments must be avoided in practical lessons!

What happens if...	What do you observe?	Why? **Guess.**
...you put lavender into the nest? **Don‘t do!**	The ants fleeing or dying.	Lavender is highly toxic for ants.
...feeding them with baking powder or yeast? **Don‘t do!**	The ants will die.	Yeast or baking powder blowing the ants to death.
...a queen gets into another ant hill? **Don‘t do!**	Normally the queen will be killed.	They kill her, even sometimes she meets some male, take their scent and steal their whole colony.
...an ant bites or stings you? **Avoid this!**	Normally no big problem, but it could be painful.	Depends on the species! Some of them might be painful. The bulldog ant in Australia is dangerous only if you are allergic to formic acid.
...you put some ten ants (from a dry meadow) into water? **Don‘t do!**	The ants will drown.	Ants of dried landscapes aren´t adapted to swim or to merge.
...mix up ants from different places? **Don‘t do!**	The ants will kill each other.	Ants from foreign nests will be traded like intruders. In a defence reaction all foreign ants will be killed.

But what you can do are the following experiments

The following list of observations don´t fit always to the observation made in field. Sometime you will be surprised of unforeseeable reactions. Try to enjoy the surprises. They are an important part of the pedagogical concept of teaching with living animals. Try to discuss with your students what had happened.

What happens if...	What do you observe?	Why? **Guess.**
...you draw a circle around an ant with a felt pen on a paper or outside circle with a small branch?	Goes round for a while.	The smell path is disconnected.
...you put a drop lavender beside the ant road?	The ants will avoid this area.	Lavender is highly toxic for ants.
...on a sunny day you put a flower pot on the nest?	In 3–4 hours (sometimes days!), ants will carry their larvae under the pot.	They prefer given dry places for their larvae (like small natural caves or hollow trunks).
...you rummage into a red wood ant nest with a piece of Chicory (or red gabbage or litmus paper)?	The ants are attacking immediately, syringing ant acid and biting. It turns red.	Red wood ants use acid for defence. Chicory has an antioxidant that gives its blue colour. This antioxidant is red in environment and blue in alkalescence (same in red gabbage or litmus paper).
...you put some ten ants (only of a wet meadow or periodical flooded areas beside rivers!) into water. Not one!	They cling together. They cannot be pushed under the water.	Due to the surface stress[1, 2, 3].

What happens if...	What do you observe?	Why? **Guess.**
...you shout at ants?	The ants are moving.	They can hear because of their sense for vibration.
...you breathe at them?	The ants moving nervously and prepare to defence.	The CO2 of the breath is the warning gas, that some animal attacks the nest.
...you touch them?	The ants are moving faster.	They feel by touching. They can be taught to recognize the smell of the human who feed them.
...you put some perfume on their road?	They will run around, move confused.	They communicate through smelling, so they can be confused by perfume. They recognize each other through the common smell of the nest.
...you present a piece of meat fixed to the floor (with needles)?	The ants will "call help".	The ants will be recruiting more workers to get the meat.
...you make a labyrinth with chalk behind a crumb of sugar? [4]	If it is possible they do not cross the line, but if it is the only way to get food, they will cross it.[5]	Smell of food is a stronger motivation than following the known path.
...you put the following materials in front of the ants: vinegar, black pepper, water, cinnamon, peppermint, ink, tomato?	React different.	They avoid: vinegar, black pepper, cinnamon, peppermint so they are good to keep them out of the house. They do not care too much about water, ink, tomato.
...you put a piece of paper in the ant road and wait till they learn that they can get through on it, and then after some minutes you turn the paper backwards.	They keep running on the underside of the paper, still following the scent line.	Because they build up a new smelling path.

1 http://www.unicafe.hu/lapozo/tutajja-alakulva-vedik-egymast-es-kiralynojuket-az-arviztol-a-hangyak/
2 https://www.youtube.com/watch?v=2bdry7_5qck#t=48
3 https://www.youtube.com/watch?v=uZSqx0PJ8XU
4 http://www.examiner.com/article/ant-science-fun-ways-to-use-ants-for-nature-studies
5 http://www.examiner.com/article/ant-science-fun-ways-to-use-ants-for-nature-studies

Student's worksheet "What happens if..."

For indoor activities with ant arena or for outdoor observation!

What happens if...	What do you observe?	Why? **Guess.**
...you draw a circle around an ant with a felt pen on a paper (indoor) or circle with a small branch (outdoor)?		
...you put a drop lavender beside the ant road?		
...on a sunny day you put a flower pot on the nest?		
...you rummage into a red wood ant nest with a piece of Chicory (or red gabbage or litmus paper)?		
...you put some ants (only of a wet meadow or periodical flooded areas beside rivers!) into water. Not one!		
...you shout at ants?		
...you breathe at them?		
...you touch them?		
...you put some perfume on their road?		
...you present a piece of meat fixed to the floor (with needles)?		
...you make a labyrinth with chalk behind a crumb of sugar? [1]		
...you put the following materials in front of the ants: vinegar, black pepper, water, cinnamon, peppermint, ink, tomato?		
...you put a piece of paper in the ant road and wait till they learn that they can get through on it, and then after some minutes you turn the paper backwards.		

1 http://www.examiner.com/article/ant-science-fun-ways-to-use-ants-for-nature-studies