The projest has been funded with the support of European Commission within ERASMUS+ program

Importance of bees

Material for students

This material has been founded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Publication free of charge.

Project office: Ks. Janusza 64, 01-452, Warsaw, Polandhttp://odyssey.igf.edu.pledukacja@igf.edu.pl

The projest has been funded with the support of European Commission within ERASMUS+ program

Introduction

Resolution

The future of humanity depends on the conservation of honeybees

Definitions

Bees
Nowadays, it is estimated the existence of approximately 20,000 species of bees. These insects exhibit several life habits, from solitary to highly social bees, which implies in a broad spectrum of habitats, because it involves different feeding and mating habits, besides varied nesting sites. Regarding the use of food resources and nesting sites, groups of bees can be categorized into generalists or specialists. The specialist group, with specialist habits, often requires morphological and behavioral specialized adaptations.

Honeybees
The European honey bee, *Apis mellifera* L., is the most commonly managed bee in the world. A highly adaptable species, it has a native range that stretched from the southern parts of Scandinavia to Central Asia and throughout Africa. Since the 1600s, however, A. mellifera's range has expanded to nearly all habitable corners of the globe. Most of the European honey bee's range expansion has been the result of deliberate human transport. ''Like the dog, the honeybee (sic) had accompanied man on most of his major migrations, and some of the early settlers in each part of the New World took hives of bees with them". Unlike dogs however, honey bees were imported by settlers for their ability to make honey and bees wax. Honey was the only sweetener available to early African, Middle Eastern and European civilizations, and demand for the product no doubt lead to the domestication of bees by the Ancient Egyptians sometime before 2600 BCE. The practice of keeping bees was passed to the ancient Greeks by 650 BCE, who in turn passed the art to the Romans (by 150 BCE) who spread the art throughout what would become medieval Europe. It was the descendants of medieval European beekeepers who eventually spread both the practice of beekeeping and the bees themselves around the world (Ransome, 1937).

Pollen
Pollen, the small spore, plays an important role in the sexual reproduction of angiosperms as does the sperm in the animals. However, the pollen grains are nonmotile requiring some foreign agent for their carry over to the female counter part. Wind, water and gravity are some of the abiotic agents, but through them the pollen carryover is undirected and very large number of pollen has to be produced to ensure successful pollination. Still the effectivity of pollination by these agents is low. On the other hand in a large number of plant species, pollination is effected by the bioagents. This is especially true in plants exhibiting self-incompatibility, protandry or protogyny. Pollination by bees is of special importance. Efficiency of pollination by bioagents is the direct measure of mutualism specialization which is reflected in terms of success of reproduction as evidenced by quality and quantity of produced seeds/fruits.

Pollination
Pollination, the transfer of pollen grains to the stigma of the plant gynoecium is a crucial step in the sexual reproduction of flowering plants. The majority of flowering plants rely on animals for the transfer of pollen (Nabhan and Buchmann 1997; Renner 1988). Because flower visitors gain no direct benefit by pollinating flowers,

rewards must lure them. The most common way plants attract animals to visit their flowers is by providing food such as nectar, pollen or oils. While searching for these rewards in the flower, pollen from the flower's anthers may stick to the body of the animal. When the animal visits subsequent flowers in search of more rewards, pollen from its body may adhere to the stigma of these flowers and again, new pollen may stick to the body of the animal.

Importance of pollination (History)

The importance of pollination in agriculture has been recognised for millennia (Kevan and Phillips 2001). Ancient Assyrian temple carvings depict winged deities pollinating female date palms with male flowers to ensure that dates would form on their trees (Buchmann and Nabhan 1996). Old Mayan screen fold books (the Madrid Codex, now housed in a Madrid museum) indicate that the ancient Maya of Mesoamerica kept stingless bees (Melipona beecheii), indicating that they knew how to manage and propagate captive colonies in log hives. Pollination was discovered by Koelreuter (1733–1806) and Sprengel (1750–1815) who are regarded as father of pollination ecology. Much of this ancient knowledge was lost until essentially modern times, with the rediscovery of sexuality in tulips by Arthur Dobbs in 1750 and other early floral biologists. The irony, however, is that although the importance, and fragility, of pollination for agriculture and Nature conservation has been known for a long time, there appears to have also been a popular belief that flowering plants always somehow seem to get pollinated and bear fruits and seeds and carry on into the next generation. Thus the science of pollination ecology has not advanced adequately, and this makes ample room for new and established researchers to contribute to knowledge about pollinators and the plants they pollinate, whether in natural or agroecosystems.

Animal pollination

Animal pollination is necessary in the life cycle of many plant species. An estimated 87.5% of the world's flowering plant species are animal pollinated, with 75% of the world's major crop species benefitting to some degree from animal pollination. Animal-pollinated plants are also used for medicines, forage, and construction materials, and play a crucial role in the long-term maintenance of biodiversity and natural ecosystems.

Introductory questions

When talking about the importance of bees, a quote attributed to Albert Einstein usually comes up: "If the bee disappeared off the face of the Earth, man would only have four years left to live." The quote was cited by the media many times, even by the more credible ones, as well as in literature. However, as it turned out, it was a hoax or fake news. The quote appeared in a leaflet from 1994 published by the French association of beekeepers. But the issue it raises nevertheless remains unresolved. The bees are key for the pollination of a number of plants used in human nutrition, but the question whether our food supply would be endangered remains unanswered. Could homo sapiens survive without bees?

Why are bees important?
What bees do for us?
Would we starve without bees?
How much does agriculture depend on pollinators?
What other pollinators are there?

The projest has been funded with the support of European Commission within ERASMUS+ program

Worksheet

Topic
Environmental biology / Food production
Resolution
The future of humanity depends on the conservation of honeybees

Task 1.

The "Introduction" tab provided by the teacher contains a set of questions to help prepare arguments for the debate. On their basis, prepare a set of arguments and group them into those that are clearly PRO the resolution, AGAINST the resolution and those arguments that can be used by both sides. Enter them in the appropriate places in the table.

PRO	DEBATABLE	CON
1. We cannot imagine the world without bees. 2. Bees are the most precious pollinators of plants. 3. Bees are threatened by extinction and should be preserved. 4. Bees need to be preserved because they pollinate crops key for our diet.		1. We don't have to imagine a world without bees because it actually exists. 2. Bees are far from being the only valuable pollinators. 3. It is not necessary to invest additional efforts in the preservation of bees since they are not endangered. 4. In no way do bees contribute to the increase in yields of plants which are most used in human diet.

The projest has been funded with the support of European Commission within ERASMUS+ program

FACTS FOR PROPER ARGUMENTATION

Below you will find Info cards, Story cards and Question cards. Read them carefully and analyse in order to formulate good arguments for the debate.

Info card 1 Facts and data	Info card 2 Facts and data	Info card 3 Facts and data	Info card 4 Facts and data
We cannot imagine the world without bees. The partnership between flowering plants and pollinating insects, especially bees, is one of the most widespread and significant symbiotic interactions on Earth. This 100 million-year-old collaboration has spawned a rich diversity of species and promoted the rise to dominance of humans. Now the need to feed our burgeoning population, coupled with the agricultural means to that end – a plethora of pesticides, the unabated loss of natural habitat and the translocation of alien species and diseases - are driving wild and managed bee populations into a very steep decline. Seventy percent of the crop species eaten by humans depend wholly or partly on pollination and recent estimates put the economic value of insect pollination at over £121 billion - representing at least 10% of the value of the world's agricultural production. Bees are irreplaceable and the debate about what might happen if they disappeared is no longer academic. We have set in motion processes that may lead to the extinction of the planet's most important pollinators along with countless other species that depend on them. Not	**Bees are the most precious pollinators of plants.** Pollination is an ecosystem service that is key to food security and wild ecosystems. Bees are essential for many fruit and vegetable crops, and the survival and spread of a large number of flowering plants. Sexual reproduction of many crops and the majority of wild plants is dependent on animal pollination through insects. Among the insect pollinators, solitary and social bees provide most pollination in both managed and natural ecosystems. No other group of insects are of more benefit to humans than bees. More than one-third of the world's crops require pollination to set seeds and fruits, and most meat and dairy industries rely on bees for pollination of clover and Lucerne. Crops relying on bee pollination include apple, citrus, tomato, melon, strawberry, apricot, peach, cherry, mango, grape, olive, carrot, potato, onion, pumpkin, bean, cucumber, sunflower, various nuts, a range of herbs, cotton, alfalfa and lavender. The annual value of this service is estimated at US$112 billion worldwide. Even crops that do not require pollination for harvesting, such as those producing fiber or timber,	**Bees are threatened by extinction and should be preserved.** Although a number of extinctions occurred in the past, bees started going rapidly extinct at the beginning of the 21st century. High mortality in honeybee colonies has been reported worldwide in recent decades without definitive identification of the causes. Several hypotheses have been postulated to explain these losses, but the causes have not been clearly identified. Many factors, including internal and external pressures, exposure to various pathogens, lack of diversity of food sources, management problems, exposure to agrochemicals and a variety of stressors, act in isolation or, more often, in combination, to drive increased mortality among individual bees or managed honey bee colonies. The presumption of ample honey bees for crop and ecosystem pollination was severely challenged in the past several years by enigmatic declines of honeybee colonies throughout the world. Due to the link between animal pollinators and global food security, any decline of managed honeybees and the loss of wild pollinators are of increasing concern. Undoubtedly, the global health of	**Bees need to be preserved because they pollinate crops key for our diet.** Would we starve without bees? If you look at the plate of food on your dinner table, bees have played their part either pollinating the many vegetables and fruits we eat directly, or pollinating the food for the animals that we then consume. And that's not all bees do for us - honey and wax are two other important products that come courtesy of bees. But honey bees are disappearing globally at an alarming rate due to pesticides, parasites, disease and habitat loss. If these little insects that help provide so much of the food we eat were to vanish, what would we do without them? By far the most important contribution honey bees make to modern agriculture is the pollination services that they provide. Honeybees are reported to play a vital role in enhancing the productivity levels of different crops such as fruit and nuts, vegetables, pulses, oilseeds and forage crops. Fifty-two of the 115 leading global food commodities depend on honeybee pollination for either fruit or seed set. Some (five) honey bee-dependant commodities would have 90% yield reduction without honey bees. In addition,

only will the world be a much less colorful place, it will also be poorer in every other way imaginable. The effects will be nothing short of catastrophic. The value of bees in pollination is undisputed and well documented. There has been no shortage of interest in studies on bees in relation to pollination. Indeed, a brief search on this subject on Google scholar shows that during the last century the publication of research papers in this area has grown exponentially, and in just the last five years, some 23,000 items have appeared. In the event, it is both fair and pertinent to ask: "Is there actually need for yet another work on the role of bees in plant pollination, the conservation of biodiversity, and agricultural production"?	still require pollination to produce further generations, and crops such as cotton that do not require pollination to produce seeds, provide greater yields when pollinators are available. The European honeybee (*Apis mellifera*) dominates crop pollination worldwide, but local native bee species also play their part. In addition to playing a crucial role in pollination and thereby improving crop yields, honeybees contribute in a balanced way to rural development efforts leading to secure and sustainable livelihoods. It is generally known that bees are needed to pollinate our crops but it is not well known that the economic value of bee pollination is several times more the value of the world-wide production of honey. Bees because of their morphological adaptations for the collection of pollen are considered to be the most efficient pollinators. Bee diversity is immense. There are more than 20,000 pollinating bee species in the world. Bees differ from many other providers of essential ecosystem services because they are often part of highly specific pollinator–plant relationships. Where there are very specific niche requirements for the plants and their pollinators, loss of the pollinator can have cascading effects across the ecosystem. For example, some bees that pollinate small herbaceous plants depend on holes in dry wood to nest, and when the wood is removed plant fecundity is reduced.	honeybees is at risk. Honeybee wellbeing is negatively affected by the intensive use of pesticides and fungicides in agriculture and the chronic exposure to acaricides needed to combat the parasitic mite Varroa destructor. Furthermore, destruction and fragmentation of natural and semi-natural habitats as well as land use intensification in agricultural landscapes have significant negative effects on honeybees and other pollinators. In addition and perhaps most importantly, honeybees are attacked by parasitic mites (Varroa destructor, Acarapis woodi, Tropilaelaps spp.), fungi (Nosema spp., Ascosphaera apis), bacteria (Paenibacillus larvae, Melissococcus plutonius), numerous viruses, and scavengers (from beetles and mice to bears) during any life stage. For some of these parasites and pathogens the consequences for individual bees and colonies are known, while for others they remain elusive. Still, it is clear that they all in one way or another reduce the fitness of their honeybee hosts.	yields in terms of fruit size, quality, or quantity would be greatly reduced (90–40%) in 16 commodities, modestly reduced(10–40%) in a further 19 commodities, and slightly reduced (<10%) in a further 13 commodities. In total, 22.6% of all agricultural production in the developing world, and 14.7% of agricultural production in the developed world is directly reliant on animal pollination to some extent. However, when foods that indirectly benefit from pollination are included,35% of the human diet is thought to benefit from pollination. Globally, the value of insect pollination has been estimated at US$ 212 billion (€153 billion), which represents about 9.5% of the total value of agricultural production. Managed honey bees are ideally suited for the pollination of large monocrop plantings for several reasons. Colonies of bees have a relatively large year round work force of 10,000–40,000 individuals, approximately one-third of which are foragers. Beekeepers can stimulate the growth of these populations in preparation of a pollination event by feeding artificial diets of sucrose or high fructose corn syrup and artificial protein diets. Further, managed colonies are maintained in standardized equipment which facilitates the transport of colonies over large distances to pollination sites. The biology of honey bees also makes them well suited as commercial pollinators. Honey bees are generalists, visiting a wide range of flower types, even those they are

			not well suited to pollinate, such as blueberries and alfalfa. Traveling an average of 4.5 km to forage, honey bees are able to pollinate crops over an area of 6360 ha, allowing colonies to be placed in groups in the center of large orchards without affecting pollination in the orchards' periphery. Further, a bee's ability to communicate the location of floral resources to her nest mates makes honey bees particularly efficient pollinators. Between1961 and 2006, agriculture industry's dependence on pollinators has increased by 50% and 62% in the developed and developing world, respectively. This rate of increase surpasses that of global increases in the number of managed honeybee colonies, suggesting that pollinators may limit production of pollinator-dependent crops in the future.

The project has been funded with the support of European Commission within ERASMUS+ program

Info card 5 Facts and data	Info card 6 Facts and data	Info card 7 Facts and data	Info card 8 Facts and data
We don't have to imagine a world without bees because it actually exists. Instead of lamenting on the extinction of bees, we should devote time to studying ecosystems which exist without bees. One of the rare such places on our planet is in Australia. Remote Macquarie Island, halfway between New Zealand and Antarctica, has provided scientists with the first glimpse of a world without bees. A contrast to the colorful flowers most of us are used to, Macquarie Island's flowers come in one color: green, and not by accident. On the island, flies are the dominant pollinator. And because flies have very different color vision system and preferences to birds and bees, the flora on the sub-Antarctic island hosts flowers with a distinctive green appearance, unlike any other in the world. Vision scientist at RMIT University, Adrian Dyer, said the power of the pollinator had influenced the color of the flowering plants' blooms. To our eye, they are just a pale green color. Although to flies, the flowers are probably more of a yellowish color, as flies have a different visual system. Some birds do exist on the island, but they are seabirds and species which don't visit flowering plants in search of nectar, so don't serve as pollinators. Professor Dyer said the researchers spent almost twenty years looking for an	**Bees are far from being the only valuable pollinators.** There is a whole line of species whose influence on pollination is enormous, and whose survival is also in danger. They are unrightfully left behind and are an incomparably less important topic than bees, even though they are highly valuable for humankind, both as pollinators of crops and as guards of ecosystems in general. Over 920 species of birds are known to pollinate plants including those belonging to the *Nectarinidae* (sunbirds), *Trochilidae* (hummingbirds), *Meliphagidae* (honeyeaters), and Loridae (lories). Birds pollinate about 5.4% of the 960 cultivated plant species for which pollinators are known and typically pollinate 5% of a region's flora or 10% of flora if that region is an island. Among mammals, bats are the major pollinators, with flower-visiting bats mostly found in two families: *Pteropodidae* (fruit bats), occurring mainly in Asia and Australia, and *Phyllostomidae* (leaf-nosed bats), distributed throughout the Neotropics. Approximately 528 plant species in 67 families and 28 orders worldwide are pollinated by bats. Non-flying mammals such as primates, rodents, and marsupials are also known to visit at least 85 species of plants worldwide. In addition, flower visitation is reported for 37 lizard species, mainly island-dwelling ones.	**It is not necessary to invest additional efforts in the preservation of bees since they are not endangered.** Bees are not dying out. On the contrary, the situation is quite the opposite and official data support this claim. For example, the number of U.S. honeybees rose in 2017 from a year earlier, and deaths of the insects attributed to a mysterious malady that's affected hives in North America and Europe declined, according to a U.S. Department of Agriculture honeybee health survey. The number of commercial U.S. honeybee colonies rose 3% to 2.89 million as of April 1, 2017 compared with a year earlier, the Agriculture Department reported. Bees are not even close to extinction, even in the parts of the world which report the biggest losses like the USA, because the number of hives was renewed every year by multiplying existing societies. Although from 2006 to date, the USA and some European countries reported severe loss of bees, beekeepers managed to make up for their numbers at the end of the year by dividing strong communities, which is a common practice in beekeeping. If 30-40% of bee communities disappeared every year, as was reported by the media, there wouldn't be any bees left today. The media often inaccurately and sensationally reported on the losses, in an effort to attract more readers, omitting the fact that	**In no way do bees contribute to the increase in yields of plants which are most used in human diet.** Back in 1992, the USDA (United States Department of Agriculture) published a guide with recommendations for a healthy diet. These recommendations were in the form of a pyramid which suggests that a person should eat more food from the bottom of the pyramid and less food and beverage from the top of the pyramid. In this case, grains were the basic food, while sugars were foods that should be avoided, i.e. their share in diet should be as small as possible. Why was the food pyramid created in the first place? The main reason behind the food pyramid was an expansion in the number of obese people, so its main task was to provide a nutritionally balanced diet with little energy. The pyramid showed proportionality and diversity in each of the five food and beverage groups, which rose in horizontal layers starting from the food that should be the most common in the diet of the foundation (bread, grains, pasta and rice), then fruits and vegetables; dairy products; eggs, fish, legumes, meat and sugar. The food pyramid has certainly changed since 1992, but the share of grains, bread, pasta and rice has certainly remained the same and is the most represented. The question is why is this so? Grains increase the pH value of the body

environment without bees, adding that it was always going to be a remote corner of the globe because where humans go, generally bees are introduced as well. Published in the journal Plant Biology, the findings provide a valuable insight into an ecosystem without the key pollinators. Professor Dyer said learning about a world without birds and bees as pollinators was important because of the as-yet unsolved, global problem of falling bee numbers which could have implications for the agricultural sector and food production. "If we don't have birds and bees and we have to rely on flies as pollinators then we may have to think about genetically engineering completely different-looking flowers," Professor Dyer said.

Located in an isolated part of the Southern Ocean, Macquarie Island is a UNESCO World Heritage site which emerged from the seabed approximately 600,000 years ago. The island has never been in contact with other land masses and is one of the most remote places on Earth. RMIT University ecologist and plant scientist Mani Shrestha said despite a limited color palette, the flowering plants on the island were diverse, hailing from six plant families found in Australia and New Zealand, including orchids.

Macquarie Island is an extreme case which confirms that ecosystems can survive without bees. It is also important to remark that in many parts of the world, especially tropics, bees are not the main pollinators, but rather different species of birds,

Researchers emphasizes the importance of conserving vertebrate pollinators, particularly in the tropics. Vertebrate pollinator-dependent crops are an important component of tropical cultivated goods (eg pitayas, agave, durian), and declining pollination services may result in substantial losses in revenue. Bat-pollinated plants have substantial economic and social value. The loss of pollinating bats, for instance, would have major consequences for the reproduction of plants such as agave and columnar cacti, which yield high monetary-valued goods – mezcal and pitayas – in the Mexican agricultural market. Furthermore, durian (*Durio zibethinus*), which depends on bats such as flying foxes (*Pteropus* spp) for pollination, is an extremely popular and economically important fruit in Southeast Asia.

Also, a loss of fruits and seeds of this magnitude, especially in tropical areas, would likely have an adverse impact on animals that depend on these resources, including birds, bats, rodents, and primates, as well as many granivorous or frugivorous invertebrate species. In the tropics, vertebrate pollinators may play important roles not only in the regeneration and restoration of degraded natural systems but also in the long-term maintenance of both natural and agricultural systems.

beekeepers generally managed to make up for the losses by dividing strong and healthy communities at the end of the beekeeping season.

Truth be told, a 2009 research based on data from around the world, shows that the number of managed bee colonies worldwide increased by 45% between 1961 and 2009. At the same time, according to the data from the same research, the demand for pollination of agricultural crops increased by 300% and that is what should be pointed out. In the USA in particular, and in other countries to a lesser extent, farmed honeybees are used primarily for pollination of agricultural crops, which has led to a relative shedding of the bee population. The use of neonicotinoids (a special type of pesticides), as well as the intensification of agriculture that has converted natural ecosystems into large agricultural plots, have endangered the health of bees, leading to a relative decline of their population.

While it is clear that global stocks of honey bees have increased over the last five decades, not all regions have experienced gains. Notably, in the period between 1961 and 2007, managed colonies decreased in both Europe (-26.5%) and North America (-49.5%), while large increases were recorded for Asia (426%), Africa (130%), South America (86%), and Oceania (39%) (FAO, 2009). Even within regions there was considerable variability in the honey bee colony population trends. For example, in North America, both the US and Mexico

and thus have a beneficial effect on strengthening immunity. They also have a favorable ratio of calcium and phosphorus, a high level of iron and folic acid, including essential amino acids. They are rich in fiber, which is of great importance for the preservation of the digestive and immune systems, which gets the body into the status of good homeostasis, or balance. All of the above makes them an important part of a healthy diet.

In order for agricultural production to be able to produce enough grain to meet food requirements, the introduction of hybrid grain varieties was of great importance. What does it actually mean? The production of hybrid varieties aims to obtain grains of known characteristics, with high yields and resistant to various plant diseases.

If we ask who is responsible for the production of grains in order to have sufficient amounts of food, the answer is certainly man. Namely, modern agricultural production follows the development of seed material, artificial fertilizers, modern mechanization (tractors, other machinery), etc. thus confirming the responsible role of the human factor. The role of bees in the production of the most common foods in the human diet is almost negligible. The question is then how these plants reproduce if the bees do not act as pollinators. Hybrid species of plants, as well as grains, are reproduced with the help of man, that is, man "controls" which parental traits will be passed on to the

reptiles, bats, and even mammals serve this purpose.		saw declines over the 46 year period, while Canada saw increases in colony numbers. In Europe, similar discrepancies in trends were apparent (FAO, 2009).	offspring. As much as bees are given priority as irreplaceable pollinators and main food producers, the facts still speak differently. As the most represented food, the production of grains is still directed by the human factor. The estimate that humans depend on animal pollination for about one-third of their food is often highlighted in the literature on the agricultural consequences of a much debated decline in pollinator abundance. Indeed, 70 % of crops that account for about 35% of all agricultural production depend to varying extents on pollinators for high-quality and high-quantity seed and fruit production. The loss of all pollinators would reduce agricultural production by an estimated 8% (from 5% (developed world) to 8% (developing world)). However, because many crops are not 100% reliant on insect pollination, some reduced production could be compensated for by increasing cultivated acreages. The loss of animal pollinators would require the developed and developing world to increase land cultivated in pollinator-dependent crops by 15% and 42%, respectively, to make up production deficits. All of the abovementioned leads us to a conclusion that if bees were to go extinct, humankind would be able to survive and food supplies would not be jeopardized.

Stories	Stories
Colony collapse disorder (CCD) On February 22, 2007, many Americans woke up to media reports that something was awry with their honey bees. A significant proportion of American beekeepers were complaining of unusually high rates of colony loss as their bees broke from their overwintering clusters. Loss of some colonies (say 10%) in early spring is normal and occurs every year. In 2007, however, losses were particularly heavy and widespread—beekeepers in 22 states (including Hawaii) reported the problem. Some beekeepers lost nearly all of their colonies. And the problem is not just in the United States. Many European beekeepers complain of the same problem. Moreover, beekeepers and researchers do not understand the specific causes of the losses. Is There a Real Problem? Were the losses in 2007 within the normal range, or is there something new afoot in the bee industry? If there is something new, what is it? Is it indicative of a general toxic overload of agricultural ecosystems, or a problem confined to the bee industry? Should beekeepers be worried? Should we be worried? The US House Agriculture Committee is sufficiently worried to be holding hearings into the matter, as well they might. Honey bees are essential pollinators: in 2000, the value of American crops pollinated by bees was estimated to be $14.6 billion. The syndrome is mysterious in that the main symptom is simply a low number of adult bees in the hive... There are no bodies, and although there are often many disease organisms present, no outward signs of disease, pests, or parasites exist. Here, I try to get to the bottom of the unsolved mystery of colony collapse disorder (CCD)—the official description of a syndrome in which many bee colonies died in the winter and spring of 2006–2007. What is CCD? The syndrome is mysterious in that the main symptom is simply a low number of adult bees in the hive. (This is a bit like going to a previously well-populated hen house and finding hardly any hens.) There are no bodies, and although there are often many disease organisms present, no outward signs of disease, pests, or parasites exist. Often there is still food in the hive, and immature bees (brood) are present. The cause of the loss of	**Einstein & Bees** (…) So it's more than a little ironic that the ability of people to communicate on the subject of honey bees is curiously deficient. There's been a lot of talk about honey bees of late, due to the sudden, devastating ppearance of what has come to be known as colony collapse disorder—the mysterious rapid decline of colonies, leaving just a handful of workers tending an apparently healthy queen along with brood and food stores (van Engelsdorp et al. 2007). Honey bees, of course, are the nation's premier managed pollinator and are responsible for commercial pollination of close to a hundred crop plants. This enigmatic disappearance, with its enormous implications for the American food supply, has proved to be irresistibly attractive to the media. Of course, the principal attraction is the opportunity to work a pun (which for want of a better word must be called bee-labored) into a headline. The Dallas Morning News remarked that the "Strange disorder has scientists, beekeepers buzzing" (April 24, 2007) while the New Haven Register more succinctly summarized the situation with the headline "Buzz, off " (April 30, 2007). The Washington Post declared "The flight of the honeybee: A mystery that matters" (May 9, 2007), the Boston Herald bee-moaned the fact that "Colony collapse disorder bee-devils farmers" (April 18, 2007), and the Detroit Free Press deemed colony collapse disorder "A sticky situation" (May 23, 2007). Meanwhile, the Boise [Idaho] Weekly was "Bee-fuddled" (May 23, 2007), the Black Hills [South Dakota] Pioneer "Bee-wildered" (May 7, 2007) and the Springfield [Illinois] State Register was "Feeling the sting" (May 19, 2007). Somewhat prematurely, perhaps anxious to work an alternative pun into the story, Newsday declared, "Experts may have found what's bugging the bees" (April 26, 2007). Most creative, I think, was the historically resonant headline, "The lost colonies," which appeared in the Zanesville [Ohio] Times Recorder (May 21, 2007), and the subtle yet apt Beatles (Bee-tles?) reference in the headline, "Give bees a chance," appearing in the online commentary magazine The Simon (May 1, 2007). Accompanying almost all of the inevitable puns in the various and sundry headlines were dire warnings of the consequences of bee disappearances. A story in the influential German newspaper Der Süddeutsche Zeitung, Germany's largest national daily paper with a circulation over 600,000, provided a pithy assessment of the gravity of the situation from the undisputed scientific genius Albert Einstein: "Wenn die Biene von der Erde verschwindet, dann hat

bees seems to be the sudden early death, in the field, of large numbers of adult workers. Curiously, the dead colonies tend to be left alone by the two cleptoparasites that normally infest dead honey bee colonies: the wax moth Gallaria mellonella and the small hive beetle Aethina tumida. Could this be due to some toxic residue in the dead colonies? Perhaps this was a contributing factor, but more likely the time of year meant that there were few cleptoparasites about—their abundance is seasonal.

Were the Losses Unusual?

Some winter losses are normal, and because the proportion of colonies dying varies enormously from year to year, it is difficult to say when a crisis is occurring and when losses are part of the normal continuum. What is clear is that about one year in ten, apiarists suffer unusually heavy colony losses. This has been going on for a long time. In Ireland, there was a "great mortality of bees" in 950, and again in 992 and 1443. One of the most famous events was in the spring of 1906, when most beekeepers on the Isle of Wight (United Kingdom) lost all of their colonies. American beekeepers also suffer heavy losses periodically. In 1903, in the Cache valley of Utah, 2000 colonies were lost to a mysterious "disappearing disease" following a "hard winter and cold spring". More recently, there was an incident in 1995 in which Pennsylvania beekeepers lost 53% of colonies .

Often terms such as "disappearing disease" or "spring dwindling" are used to describe the syndrome in which large numbers of colonies die in spring due to a lack of adult bees. However in 2007, some beekeepers experienced 80–100% losses. This is certainly the extreme end of a continuum, so perhaps there is indeed some new factor in play.

Benjamin P Oldroyd, What's Killing American Honey Bees?, PLoS Biol. 2007 Jun; 5(6): e168

der Mensch nur noch 4 Jahre zu leben," or, loosely translated, "If bees disappear from the earth, humans will cease to exist within four years." I came across this story not because I'm in the habit of perusing German periodicals but rather because I was interviewed for the story and the journalist sent me a copy. I was quoted in the story as saying, among other things, "Wenn Sie einen Hamburger essen ... dann verdanken Sie das indirekt den Bienen," which is, roughly translated, "Whenever you eat a hamburger, you have a bee indirectly to thank." I'm sure my high-school German teacher would have been pleased by the grammatical correctness, but, as pithy or quotable phrases go, it certainly falls far short of the Einstein quotation, in either language. As for that Einstein quotation, it certainly sounded authoritative and credible, particularly in German. Even in translation, however, it didn't sound familiar.

(…)

As it turns out, I was certainly not the only one who couldn't find the quotation in any of Einstein's writings. Before I stumbled across it, the Web site Snopes.com, devoted to quashing Internet rumors, had already dispensed with questions surrounding its authenticity (April 21, 2007), reporting that at least one Einstein biographer, Walter Isaacson, and the author of The New Quotable Einstein, Alice Calaprice, had never come across it in their extensive research. According to the site, the quotation appears not to have existed before 1994, almost a half-century after Einstein died. So, if Einstein did indeed say it, he must have said it at a séance through a medium. The quotation appeared to have materialized for the first time in a pamphlet published by the National Union of French Apiculture in the midst of concerns throughout Europe about unfair price competition from cheap honey imports and looming tariff reductions predicted to exacerbate the problem. In the pamphlet, beekeepers warned of the dire consequences of a collapse of their industry, invoking Einstein in predicting that honey dumping by China could well mean the end of human civilization on earth.

(…)

But back to the central question—would mankind survive to see its next leap year if bees disappeared? As annoying as I find the term "mankind" (inasmuch as the planetary majority of Homo sapiens lacks a Y chromosome), it could indeed survive without honey bees. Among other things, the vast bulk of calories ingested worldwide—mostly from wheat, rice, corn, or other grains—are contributed by plants that don't need any pollinators at all. And although bees do pollinate the majority of fruits, nuts, and vegetables, fortunately for the future of humanity many other sources of fruits and vegetables rely on pollinators other than bees. Onions and cacao (the source of chocolate) are pollinated by flies, figs are pollinated by wasps, and several tropical fruits, including durian, are pollinated by bats. So, although our diet may be considerably duller,

at least we wouldn't be entirely bee-reft of fruits (or puns, for that matter).

May R. Berenbaum, *The Earwig's Tail: a modern bestiary of multi-legged legends*, Harvard University Press, 2009.

The projest has been funded with the support of European Commission within ERASMUS+ program

Issue card 1 Questions	Issue card 2 Questions	Issue card 3 Questions	Issue card 4 Questions
Question: Can we imagine a world without bees?	**Question**: Are we in danger of losing other pollinators as well?	**Question**: Are bees really endangered?	**Question**: Does modern agriculture depend on bees?
Issue card 5 Questions	**Issue card 6 Questions**	**Issue card 7 Questions**	**Issue card 8 Questions**
Question: Could the world exist without bees?	**Question**: Are bees the only pollinators?	**Question**: Is it really true that bees are endangered?	**Question** Would the loss of pollinators jeopardize humanity and food supply?

The projest has been funded with the support of European Commission within ERASMUS+ program

Prepare arguments for the discussion. One group of students prepares arguments supporting the resolution, the other one has contradictory arguments. Use the proposed scheme.

ARGUMENT NO. 1.

Argument	Foreseen rebuttals of the other group	Answers to rebuttals

The projest has been funded with the support of European Commission within ERASMUS+ program

ARGUMENT 2.

Argument	Foreseen rebuttals of the other group	Answers to rebuttals

The projest has been funded with the support of European Commission within ERASMUS+ program

ARGUMENT 3.

Argument	Foreseen rebuttals of the other group	Answers to rebuttals

Odyssey
Oxford Debates for Youths in Science Education

Erasmus+

Debate

The future of humanity depends on the conservation of honeybees

Topic: Ecology / Food production

Institute of Geophysics
Polish Academy of Sciences

CENTER FOR THE PROMOTION OF SCIENCE

IRESE

ENERGIA
AVASTUSKESKUS
ENERGY DISCOVERY CENTRE

Basic terms

- **Bees** - Nowadays, it is estimated the existence of approximately 20,000 species of bees. These insects exhibit several life habits, from solitary to highly social bees, which implies in a broad spectrum of habitats, because it involves different feeding and mating habits, besides varied nesting sites. Regarding the use of food resources and nesting sites, groups of bees can be categorized into generalists or specialists. The specialist group, with specialist habits, often requires morphological and behavioral specialized adaptations.

- **Honeybees** - The European honey bee, Apis mellifera L., is the most commonly managed bee in the world. A highly adaptable species, it has a native range that stretched from the southern parts of Scandinavia to Central Asia and throughout Africa. Since the 1600s, however, A. mellifera's range has expanded to nearly all habitable corners of the globe. Most of the European honey bee's range expansion has been the result of deliberate human transport. ''Like the dog, the honeybee (sic) had accompanied man on most of his major migrations, and some of the early settlers in each part of the New World took hives of bees with them". Unlike dogs however, honey bees were imported by settlers for their ability to make honey and bees wax. Honey was the only sweetener available to early African, Middle Eastern and European civilizations, and demand for the product no doubt lead to the domestication of bees by the Ancient Egyptians sometime before 2600 BCE. The practice of keeping bees was passed to the ancient Greeks by 650 BCE, who in turn passed the art to the Romans (by 150 BCE) who spread the art throughout what would become medieval Europe. It was the descendants of medieval European beekeepers who eventually spread both the practice of beekeeping and the bees themselves around the world (Ransome, 1937).

- **Pollen** - the small spore, plays an important role in the sexual reproduction of angiosperms as does the sperm in the animals. However, the pollen grains are nonmotile requiring some foreign agent for their carry over to the female counter part. Wind, water and gravity are some of the abiotic agents, but through them the pollen carryover is undirected and very large number of pollen has to be produced to ensure successful pollination. Still the effectivity of pollination by these agents is low. On the other hand in a large number of plant species, pollination is effected by the bioagents. This is especially true in plants exhibiting self-incompatibility, protandry or protogyny. Pollination by bees is of special importance. Efficiency of pollination by bioagents is the direct measure of mutualism specialization which is reflected in terms of success of reproduction as evidenced by quality and quantity of produced seeds/fruits.

- **Pollination** - the transfer of pollen grains to the stigma of the plant gynoecium is a crucial step in the sexual reproduction of flowering plants. The majority of flowering plants rely on animals for the transfer of pollen (Nabhan and Buchmann 1997; Renner 1988). Because flower visitors gain no direct benefit by pollinating flowers, rewards must lure them. The most common way plants attract animals to visit their flowers is by providing food such as nectar, pollen or oils. While searching for these rewards in the flower, pollen from the flower's anthers may stick to the body of the animal. When the animal visits subsequent flowers in search of more rewards, pollen from its body may adhere to the stigma of these flowers and again, new pollen may stick to the body of the animal.

- **Importance of pollination (History)** - in agriculture has been recognised for millennia (Kevan and Phillips 2001). Ancient Assyrian temple carvings depict winged deities pollinating female date palms with male flowers to ensure that dates would form on their trees (Buchmann and Nabhan 1996). Old Mayan screen fold books (the Madrid Codex, now housed in a Madrid museum) indicate that the ancient Maya of Mesoamerica kept stingless bees (Melipona beecheii), indicating that they knew how to manage and propagate captive colonies in log hives. Pollination was discovered by Koelreuter (1733–1806) and Sprengel (1750–1815) who are regarded as father of pollination ecology. Much of this ancient knowledge was lost until essentially modern times, with the rediscovery of sexuality in tulips by Arthur Dobbs in 1750 and other early floral biologists. The irony, however, is that although the importance, and fragility, of pollination for agriculture and Nature conservation has been known for a long time, there appears to have also been a popular belief that flowering plants always somehow seem to get pollinated and bear fruits and seeds and carry on into the next generation. Thus the science of pollination ecology has not advanced adequately, and this makes ample room for new and established researchers to contribute to knowledge about pollinators and the plants they pollinate, whether in natural or agroecosystems.

- **Animal pollination** - is necessary in the life cycle of many plant species. An estimated 87.5% of the world's flowering plant species are animal pollinated, with 75% of the world's major crop species benefitting to some degree from animal pollination. Animal-pollinated plants are also used for medicines, forage, and construction materials, and play a crucial role in the long-term maintenance of biodiversity and natural ecosystems.

Odyssey
Oxford Debates for Youths in Science Education

Erasmus+

Introductory questions

- Why are bees important?
- What bees do for us?
- Would we starve without bees?
- How much does agriculture depend on pollinators?
- What other pollinators are there?

Source: Sebastien Rosset / Unsplash

RESOLUTION: The future of humanity depends on the conservation of honeybees

Source:
Damien Tupinier / Unsplash

Odyssey
Oxford Debates for Youths in Science Education

Erasmus+

PRO

1. We cannot imagine the world without bees.
2. Bees are the most precious pollinators of plants.
3. Bees are threatened by extinction and should be preserved.
4. Bees need to be preserved because they pollinate crops key for our diet.

CON

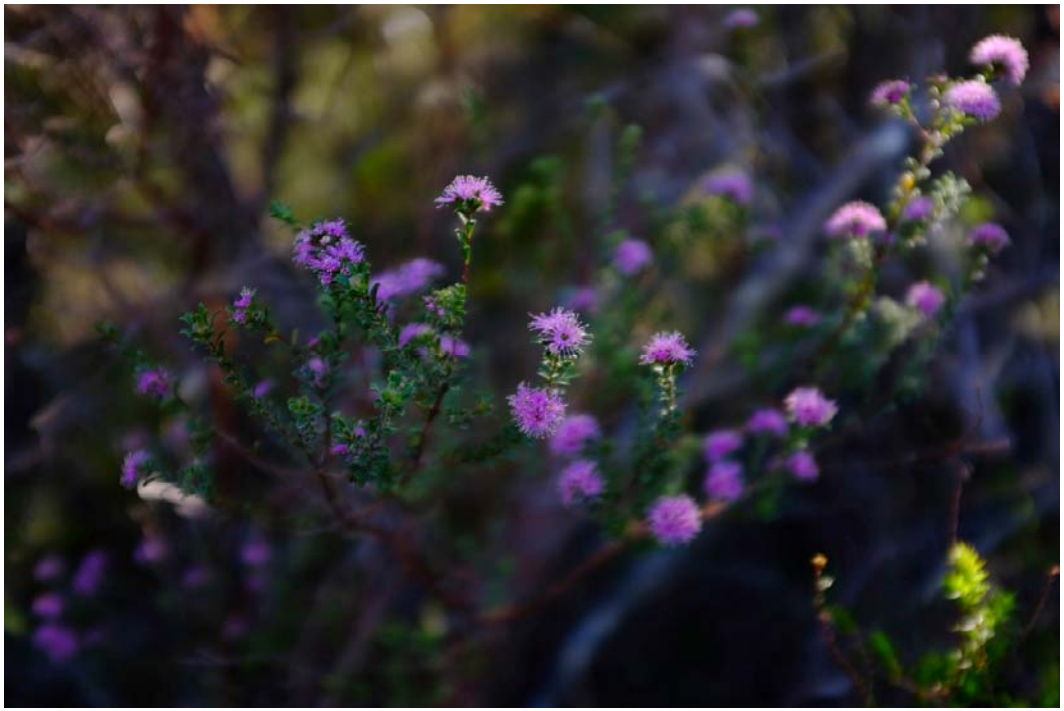
1. We don't have to imagine a world without bees because it actually exists.
2. Bees are far from being the only valuable pollinators.
3. It is not necessary to invest additional efforts in the preservation of bees since they are not endangered.
4. In no way do bees contribute to the increase in yields of plants which are most used in human diet.

1. We cannot imagine the world without bees. (PRO)

Source:
Damien Tupinier / Unsplash

- The partnership between flowering plants and pollinating insects, especially bees, is one of the most widespread and significant symbiotic interactions on Earth.
- Now the need to feed our burgeoning population, coupled with the agricultural means to that end – a plethora of pesticides, the unabated loss of natural habitat and the translocation of alien species and diseases - are driving wild and managed bee populations into a very steep decline.
- Seventy percent of the crop species eaten by humans depend wholly or partly on pollination and recent estimates put the economic value of insect pollination at over £121 billion - representing at least 10% of the value of the world's agricultural production.
- The value of bees in pollination is undisputed and well documented.
- During the last century the publication of research papers in this area has grown exponentially, and in just the last five years, some 23,000 items have appeared

1. We don't have to imagine a world without bees because it actually exists. (CON)



Извор:
Ranah Malberg / Unsplash

- Instead of lamenting on the extinction of bees, we should devote time to studying ecosystems which exist without bees
- Remote Macquarie Island, halfway between New Zealand and Antarctica, has provided scientists with the first glimpse of a world without bees.
- A contrast to the colorful flowers most of us are used to, Macquarie Island's flowers come in one color: green, and not by accident. On the island, flies are the dominant pollinator.
- Flies have very different color vision system and preferences to birds and bees, the flora on the sub-Antarctic island hosts flowers with a distinctive green appearance, unlike any other in the world.

- Vision scientist at RMIT University, Adrian Dyer, said the power of the pollinator had influenced the color of the flowering plants' blooms.
- The researchers spent almost twenty years looking for an environment without bees, adding that it was always going to be a remote corner of the globe because where humans go, generally bees are introduced as well.
- "If we don't have birds and bees and we have to rely on flies as pollinators then we may have to think about genetically engineering completely different-looking flowers."
- Macquarie Island is an extreme case which confirms that ecosystems can survive without bees.

2. Bees are the most precious pollinators of plants. (PRO)

Source: Brinzan Sabina / Unsplash

- Pollination is an ecosystem service that is key to food security and wild ecosystems.
- Bees are essential for many fruit and vegetable crops, and the survival and spread of a large number of flowering plants.
- Sexual reproduction of many crops and the majority of wild plants is dependent on animal pollination through insects. Among the insect pollinators, solitary and social bees provide most pollination in both managed and natural ecosystems.
- There are more than 20,000 pollinating bee species in the world. No other group of insects are of more benefit to humans than bees.
- The annual value of this service is estimated at US$112 billion worldwide.

- More than one-third of the world's crops require pollination to set seeds and fruits - crops relying on bee pollination include apple, citrus, tomato, melon, strawberry, apricot, peach, cherry, mango, grape, olive, carrot, potato, onion, pumpkin, bean, cucumber, sunflower, various nuts, a range of herbs, cotton, alfalfa and lavender.
- The European honeybee (*Apis mellifera*) dominates crop pollination worldwide, but local native bee species also play their part.
- Honeybees contribute in a balanced way to rural development efforts leading to secure and sustainable livelihoods.
- It is generally known that bees are needed to pollinate our crops but it is not well known that the economic value of bee pollination is several times more the value of the world-wide production of honey.

2. Bees are far from being the only valuable pollinators. (CON)

Source: James Wainscoat / Unsplash

- There is a whole line of species whose influence on pollination is enormous, and whose survival is also in danger.
- Over 920 species of birds are known to pollinate plants including those belonging to the Nectarinidae (sunbirds), Trochilidae (hummingbirds), Meliphagidae (honeyeaters), and Loridae (lories).
- Birds pollinate about 5.4% of the 960 cultivated plant species for which pollinators are known and typically pollinate 5% of a region's flora or 10% of flora if that region is an island.

- Among mammals, bats are the major pollinators, with flower-visiting bats mostly found in two families: Pteropodidae (fruit bats), occurring mainly in Asia and Australia, and Phyllostomidae (leaf-nosed bats), distributed throughout the Neotropics.
- Approximately 528 plant species in 67 families and 28 orders worldwide are pollinated by bats. Non-flying mammals such as primates, rodents, and marsupials are also known to visit at least 85 species of plants worldwide.
- Bat-pollinated plants have substantial economic and social value.
- In the tropics, vertebrate pollinators may play important roles not only in the regeneration and restoration of degraded natural systems but also in the long-term maintenance of both natural and agricultural systems.

3. Bees are threatened by extinction and should be preserved. (PRO)

Source: Bianca Ackermann / Unsplash

- Although a number of extinctions occurred in the past, bees started going rapidly extinct at the beginning of the 21st century.
- High mortality in honeybee colonies has been reported worldwide in recent decades without definitive identification of the causes. Several hypotheses have been postulated to explain these losses, but the causes have not been clearly identified.
- Many factors, including internal and external pressures, exposure to various pathogens, lack of diversity of food sources, management problems, exposure to agrochemicals and a variety of stressors, act in isolation or, more often, in combination, to drive increased mortality among individual bees or managed honey bee colonies.

- Due to the link between animal pollinators and global food security, any decline of managed honeybees and the loss of wild pollinators are of increasing concern.
- Honeybee wellbeing is negatively affected by the intensive use of pesticides and fungicides in agriculture and the chronic exposure to acaricides needed to combat the parasitic mite Varroa destructor.
- destruction and fragmentation of natural and semi-natural habitats as well as land use intensification in agricultural landscapes have significant negative effects on honeybees and other pollinators.
- Honeybees are attacked by parasitic mites (Varroa destructor, Acarapis woodi, Tropilaelaps spp.), fungi (Nosema spp., Ascosphaera apis), bacteria (Paenibacillus larvae, Melissococcus plutonius), numerous viruses, and scavengers (from beetles and mice to bears) during any life stage.

3. It is not necessary to invest additional efforts in the preservation of bees since they are not endangered. (CON)

Source: Pawel Sroka / Unsplash

- Bees are not dying out. On the contrary, the situation is quite the opposite and official data support this claim.
- The number of U.S. honeybees rose in 2017 from a year earlier, and deaths of the insects attributed to a mysterious malady that's affected hives in North America and Europe declined.
- The number of commercial U.S. honeybee colonies rose 3% to 2.89 million as of April 1, 2017 compared with a year earlier.
- Bees are not even close to extinction, even in the parts of the world which report the biggest losses like the USA, because the number of hives was renewed every year by multiplying existing societies.

- If 30-40% of bee communities disappeared every year, as was reported by the media, there wouldn't be any bees left today.
- The media often inaccurately and sensationally reported on the losses.
- Research based on data from around the world, shows that the number of managed bee colonies worldwide increased by 45% between 1961 and 2009. At the same time, the demand for pollination of agricultural crops increased by 300% and that is what should be pointed out.
- The use of neonicotinoids (a special type of pesticides), as well as the intensification of agriculture that has converted natural ecosystems into large agricultural plots, have endangered the health of bees, leading to a relative decline of their population.
- While it is clear that global stocks of honey bees have increased over the last five decades, not all regions have experienced gains.

4. Bees need to be preserved because they pollinate crops key for our diet. (PRO)

Source: Joseph Northcutt

Odyssey
Oxford Debates for Youths in Science Education

Erasmus+

- Would we starve without bees?
- Bees have played their part either pollinating the many vegetables and fruits we eat directly, or pollinating the food for the animals that we then consume.
- Honey and wax are two other important products that come courtesy of bees.
- Honey bees are disappearing globally at an alarming rate due to pesticides, parasites, disease and habitat loss.
- Honeybees are reported to play a vital role in enhancing the productivity levels of different crops such as fruit and nuts, vegetables, pulses, oilseeds and forage crops.
- Fifty-two of the 115 leading global food commodities depend on honeybee pollination for either fruit or seed set.

- Some honey bee-dependant commodities would have 90% yield reduction without honey bees.
- In total, 22.6% of all agricultural production in the developing world, and 14.7% of agricultural production in the developed world is directly reliant on animal pollination to some extent.
- When foods that indirectly benefit from pollination are included,35% of the human diet is thought to benefit from pollination.
- The value of insect pollination has been estimated at US$ 212 billion (€153 billion), which represents about 9.5% of the total value of agricultural production.
- Managed honey bees are ideally suited for the pollination of large monocrop plantings for several reasons.

- The biology of honey bees also makes them well suited as commercial pollinators. Honey bees are generalists, visiting a wide range of flower types, even those they are not well suited to pollinate, such as blueberries and alfalfa.
- Traveling an average of 4.5 km to forage, honey bees are able to pollinate crops over an area of 6360 ha.
- A bee's ability to communicate the location of floral resources to her nest mates makes honey bees particularly efficient pollinators.
- Between 1961 and 2006, agriculture industry's dependence on pollinators has increased by 50% and 62% in the developed and developing world, respectively.

4. In no way do bees contribute to the increase in yields of plants which are most used in human diet. (CON)

Source: Lambros Lyrarakis / Unsplash

- Back in 1992, the USDA (United States Department of Agriculture) published a guide with recommendations for a healthy diet. These recommendations were in the form of a pyramid which suggests that a person should eat more food from the bottom of the pyramid and less food and beverage from the top of the pyramid.
- Why was the food pyramid created in the first place? The main reason behind the food pyramid was an expansion in the number of obese people, so its main task was to provide a nutritionally balanced diet with little energy.
- The pyramid showed proportionality and diversity in each of the five food and beverage groups, which rose in horizontal layers starting from the food that should be the most common in the diet of the foundation (bread, grains, pasta and rice), then fruits and vegetables; dairy products; eggs, fish, legumes, meat and sugar.

- The food pyramid has certainly changed since 1992, but the share of grains, bread, pasta and rice has certainly remained the same and is the most represented.
- Grains increase the pH value of the body and thus have a beneficial effect on strengthening immunity.
- They also have a favorable ratio of calcium and phosphorus, a high level of iron and folic acid, including essential amino acids. They are rich in fiber, which is of great importance for the preservation of the digestive and immune systems, which gets the body into the status of good homeostasis, or balance.
- In order for agricultural production to be able to produce enough grain to meet food requirements, the introduction of hybrid grain varieties was of great importance.

- The production of hybrid varieties aims to obtain grains of known characteristics, with high yields and resistant to various plant diseases.
- Man is responsible for the production of grains in order to have sufficient amounts of food. Modern agricultural production follows the development of seed material, artificial fertilizers, modern mechanization (tractors, other machinery), etc. thus confirming the responsible role of the human factor.
- The role of bees in the production of the most common foods in the human diet is almost negligible.
- Hybrid species of plants, as well as grains, are reproduced with the help of man.
- As much as bees are given priority as irreplaceable pollinators and main food producers, the facts still speak differently.
- Humankind would be able to survive and food supplies would not be jeopardized.

Source: Leandro Fregoni / Unsplash

Colony collapse disorder (CCD)

„On February 22, 2007, many Americans woke up to media reports that something was awry with their honey bees. A significant proportion of American beekeepers were complaining of unusually high rates of colony loss as their bees broke from their overwintering clusters. Loss of some colonies (say 10%) in early spring is normal and occurs every year. In 2007, however, losses were particularly heavy and widespread—beekeepers in 22 states (including Hawaii) reported the problem. Some beekeepers lost nearly all of their colonies. And the problem is not just in the United States. Many European beekeepers complain of the same problem. Moreover, beekeepers and researchers do not understand the specific causes of the losses.

Is There a Real Problem?

Were the losses in 2007 within the normal range, or is there something new afoot in the bee industry? If there is something new, what is it? Is it indicative of a general toxic overload of agricultural ecosystems, or a problem confined to the bee industry? Should beekeepers be worried? Should we be worried? The US House Agriculture Committee is sufficiently worried to be holding hearings into the matter, as well they might. Honey bees are essential pollinators: in 2000, the value of American crops pollinated by bees was estimated to be $14.6 billion.

The syndrome is mysterious in that the main symptom is simply a low number of adult bees in the hive... There are no bodies, and although there are often many disease organisms present, no outward signs of disease, pests, or parasites exist.

Here, I try to get to the bottom of the unsolved mystery of colony collapse disorder (CCD)—the official description of a syndrome in which many bee colonies died in the winter and spring of 2006–2007.“

What is CCD?

The syndrome is mysterious in that the main symptom is simply a low number of adult bees in the hive. (This is a bit like going to a previously well-populated hen house and finding hardly any hens.) There are no bodies, and although there are often many disease organisms present, no outward signs of disease, pests, or parasites exist. Often there is still food in the hive, and immature bees (brood) are present. The cause of the loss of bees seems to be the sudden early death, in the field, of large numbers of adult workers. Curiously, the dead colonies tend to be left alone by the two cleptoparasites that normally infest dead honey bee colonies: the wax moth Gallaria mellonella and the small hive beetle Aethina tumida. Could this be due to some toxic residue in the dead colonies? Perhaps this was a contributing factor, but more likely the time of year meant that there were few cleptoparasites about—their abundance is seasonal.

Were the Losses Unusual?

Some winter losses are normal, and because the proportion of colonies dying varies enormously from year to year, it is difficult to say when a crisis is occurring and when losses are part of the normal continuum. What is clear is that about one year in ten, apiarists suffer unusually heavy colony losses. This has been going on for a long time. In Ireland, there was a “great mortality of bees” in 950, and again in 992 and 1443 [3]. One of the most famous events was in the spring of 1906, when most beekeepers on the Isle of Wight (United Kingdom) lost all of their colonies [4]. American beekeepers also suffer heavy losses periodically. In 1903, in the Cache valley of Utah, 2000 colonies were lost to a mysterious “disappearing disease” following a “hard winter and cold spring”. More recently, there was an incident in 1995 in which Pennsylvania beekeepers lost 53% of colonies .

Often terms such as “disappearing disease” or “spring dwindling” are used to describe the syndrome in which large numbers of colonies die in spring due to a lack of adult bees [7,8,9]. However in 2007, some beekeepers experienced 80–100% losses. This is certainly the extreme end of a continuum, so perhaps there is indeed some new factor in play.

Benjamin P Oldroyd, What's Killing American Honey Bees?, PLoS Biol. 2007 Jun; 5(6): e168

Source: Shelby Cohron / Unsplash

Einstein & Bees

„A story in the influential German newspaper Der Süddeutsche Zeitung, Germany's largest national daily paper with a circulation over 600,000, provided a pithy assessment of the gravity of the situation from the undisputed scientific genius Albert Einstein: "Wenn die Biene von der Erde verschwindet, dann hat der Mensch nur noch 4 Jahre zu leben," or, loosely translated, "If bees disappear from the earth, humans will cease to exist within four years." I came across this story not because I'm in the habit of perusing German periodicals but rather because I was interviewed for the story and the journalist sent me a copy. I was quoted in the story as saying, among other things, "Wenn Sie einen Hamburger essen ... dann verdanken Sie das indirekt den Bienen," which is, roughly translated, "Whenever you eat a hamburger, you have a bee indirectly to thank." I'm sure my high-school German teacher would have been pleased by the grammatical correctness, but, as pithy or quotable phrases go, it certainly falls far short of the Einstein quotation, in either language. As for that Einstein quotation, it certainly sounded authoritative and credible, particularly in German. Even in translation, however, it didn't sound familiar."

„As it turns out, I was certainly not the only one who couldn't find the quotation in any of Einstein's writings. Before I stumbled across it, the Web site Snopes.com, devoted to quashing Internet rumors, had already dispensed with questions surrounding its authenticity (April 21, 2007), reporting that at least one Einstein biographer, Walter Isaacson, and the author of The New Quotable Einstein, Alice Calaprice, had never come across it in their extensive research. According to the site, the quotation appears not to have existed before 1994, almost a half-century after Einstein died. So, if Einstein did indeed say it, he must have said it at a séance through a medium. The quotation appeared to have materialized for the first time in a pamphlet published by the National Union of French Apiculture in the midst of concerns throughout Europe about unfair price competition from cheap honey imports and looming tariff reductions predicted to exacerbate the problem. In the pamphlet, beekeepers warned of the dire consequences of a collapse of their industry, invoking Einstein in predicting that honey dumping by China could well mean the end of human civilization on earth."

May R. Berenbaum, The Earwig's Tail: a modern bestiary of multi-legged legends, Harvard University Press, 2009.

Source: Annie Spratt / Unsplash

Video materials

- Ivan Umeljić / ODYSSEY Debate: The future of humanity depends on the conservation of honeybees: https://youtu.be/Q2V_jiRUFcg
- Dennis vanEngelsdorp: Where have the bees gone?
- https://www.youtube.com/watch?v=3GXlvP4kLHg
- Marla Spivak: Why bees are disappearing
- https://www.youtube.com/watch?v=dY7iATJVCso
- Tom Seeley: Darwinian beekeeping
- https://www.cornell.edu/video/professor-tom-seeley-explains-darwinian-beekeeping
- Louie Schwartzberg: The hidden beauty of pollination
- https://www.youtube.com/watch?v=eqsXc_aefKI

The projest has been funded with the support of European Commission within ERASMUS+ program

The future of humanity depends on the conservation of honeybees

Material for teachers

With methodological guidelines, a lesson plan and an answer key to worksheets

The educational package "The future of humanity depends on the conservation of honeybees" was developed within "Oxford debates for the Youths in Science Education" project.
It is a key material, facilitating the achievement of primary project goals, including increasing reasoning skills and interest in STEM, which in the future may result in taking up a scientific career.
When preparing students for the debate, one should not neglect the development of such skills as: communication excellence, argumentation or public speaking. Students should improve theirability to persuade effectively, argue properly, reason accordingly and speak out correctly. Composition of texts, using rhetorical means in oral statements, speaking in accordance with the rules of language culture, text interpretation, public speaking and presentation of texts, discussions and negotiations are of equally high importance.
In order to achieve the abovementioned goals, the implementation of thematic educational packages should be preceded by classes dedicated to preparation for debating as such.This can be accomplishedin consultation with teachers of other subjects and the class teacher. The development of basic communication skills can be included in the class teacher's work plan, and the prepared lesson plans can be used during regular classes. Auxiliary materials can be found in the following documents:

1. **Warm up practice**– Annex No 2to National frameworks for implementation of Oxford debates in STEM in school practice;This document includes the following exercises: active listening, public speaking and debating skills.

2. **Lesson plans aimed at general development of debating skills** – Annex No 2 do National frameworks for implementation of Oxford debates in STEM in school practice;

   This material consists of 7 lesson plans prepared by Dr.FoteiniEnglezou, president of the Hellenic Institute for Rhetorical and Communication Research. Scenarios are a guide to work. It is not necessary to follow all the lessons. The teacher can decide which scenarios (or their selected fragments) are most useful for working with a specific group of students. The document offers the following lesson plans:

   1. Communication skills
   2. Express your scientific argument, not your opinion
   3. Build a valid scientific argument
   4. Searching for evidence
   5. Enhancing students' linguistic skills
   6. Rebuttal and refutation
   7. Fallacies

3. Methodological Guide for Teachers. ODYSSEY: Oxford Debates for Youths in Science Education

The final stage of preparation for debates based on specific packages is to familiarize students with the principles of debating, described in detail in the abovementioned document.

The projest has been funded with the support of European Commission within ERASMUS+ program

The future of humanity depends on the conservation of honeybees.

"The future of humanity depends on the conservation of honeybees" educational package consists of the following elements:

- Multimedia presentation;
- Video-recording based on the presentation: https://youtu.be/Q2V_jiRUFcg
- Educational package "The future of humanity depends on the conservation of honeybees" - material for students;
- Worksheets (the same for all packages);
- "The future of humanity depends on the conservation of honeybees" - material for the teacher (withanswer key).

It is recommended to implement the package during a minimum of three lesson units.

When talking about the importance of bees, a quote attributed to Albert Einstein usually comes up: “If the bee disappeared off the face of the Earth, man would only have four years left to live.” The quote was cited by the media many times, even by the more credible ones, as well as in literature. However, as it turned out, it was a hoax or fake news. The quote appeared in a leaflet from 1994 published by the French association of beekeepers. But the issue it raises nevertheless remains unresolved. The bees are key for the pollination of a number of plants used in human nutrition, but the question whether our food supply would be endangered remains unanswered. Could homo sapiens survive without bees?

The presented educational package "The future of humanity depends on the conservation of honeybees" includes an overview of several important aspects of conservation biology through a popular topic, often written and spoken about in the public in a superficial manner, presenting invalid data. Through formulating pro and con arguments, students will be able to further their knowledge of the biology of bees, as well as plant reproduction of both wild and cultivated species. Finally and most importantly, they will view our relationship with plants and animals from different angles.

The debate on the resolution: "The future of humanity depends on the conservation of honeybees" may take place both during extracurricular activities in the field of biology. The level of the materials is adjusted mainly to secondary schools.

Lesson 1. To what extent does man depend on bees?

Bee biology, plant reproduction, and the role of pollinators in preserving ecosystems are not new topics for students. Although they came across these topics earlier in their education, the complexity of their relationship, as well as the degree of human dependence on all of them in the ecosystem are lesser known and relatively new topics that have equally captured the attention of scientists and citizens recently. Through pro and con arguments, students will have the opportunity to deepen their understanding of the many complex interactions in nature, but also to better understand where our food comes from.

It is recommended that students receive the materials a few days prior to the lesson. This will allow them to get acquainted with the topic of the lesson initially and facilitate active participation in the classroom. A multimedia presentation or a video recorded by the author of the package can be used during the lesson. An open discussion of selected (previously assigned to students) applications of AI is also beneficial.

Lesson 2. "The future of humanity depends on the conservation of honeybees" – constructing arguments for and against the resolution

The aim of the second lesson is to formulate as many arguments as possible (both for and against the resolution) that will be used by students during the debate, summarizing the work with the package.

Lesson plan

1. Organizational issues, checking the attendance list, familiarizing with the topic and objectives of the lesson [5 minutes].
2. Preparation of arguments [25 minutes]
3. The teacher divides the class into teams of two. Each team receives 8 question cards available in the educational package (materials for the student) and 2 copies of worksheet No. 1 (one for each student individually). Based on the questions, students formulate arguments for the presented thesis, against the thesis and those that are debatable and can be used in the discussion by both parties. Students work together, but each student individually completes his/her worksheet. There are examples of selected arguments for worksheet 1 are in the answer key.
4. Teams: proposition and opposition are formed [10 minutes].

Team selection may be executed in 2 forms, each of them having both advantages and disadvantages.

Students declare which arguments are closer to their beliefs. The teacher divides the class into teams (each with a similar number of students) in the manner reflecting their convictions. The second method assumes a division similar to the one above, with the difference that ultimately the team consisting of the supporters of a given resolution becomes the "opposition" team, while the opponents of the thesis become “proposition” team. The supporters of such a division assume that it teaches the participants of the debate to a greater extent to use arguments supported by facts, and is less based on emotions. Alternatively, division into teams can also be done randomly.

Finally, team selection can also be made by the teacher in a subjective way, ensuring that each team has both leaders and students who require more help, so that both teams have similar “winning potential”. In order to save time for division, the teacher can do it at the beginning of the lesson, for example by distributing worksheets number 1 to the students, printed on sheets of different colour or marked in some other manner.

5. The teacher distributes worksheets number 2 to the students (one for each student) and explains the homework. An example of a filledout worksheet is available in the answer key.
6. Students in each team read prepared arguments in accordance with the assignment to a given group. Each student receives 1 argument, which he/she will develop (as homework) according to the guidelines in worksheet No.2.
7. Each team also appoints 3 people who will present the arguments prepared by the entire group. Students decide the order of their speeches. During the debate, other team members who are not directly involved in the debate, fill out worksheet
8. Summary of the lesson, evaluation of students' work [5 minutes].

Lesson 3. Debate

During the final lesson, the teams conduct a debate according to the guidelines contained in the "Methodological Guide ..." It takes 45 minutes in total to conduct a full debate. During the debate, the teacher does not comment on the arguments or indicate the fallacies made by the students on an ongoing basis.

An exercise-based debate should be structured as follows:

1. Opening of the debate by the moderator/chairperson[3 minutes].
2. Initial vote by the audience[2 minutes].
3. 1 st Researcher-Debater of the A research-team: Constructive Speech [4 minutes].
4. 1 st Researcher-Debater of the B research-team: Constructive Speech [4 minutes].
5. Cross-fire between the researchers-debaters (1) of both research teams [3 minutes].
6. 2 nd Researcher-Debater of the A research-team: Rebuttal Speech[4 minutes].
7. 2 nd Researcher-Debater of the B research-team: Rebuttal Speech[4 minutes]
8. Cross-fire between the researchers-debaters (2) of both research teams [3 minutes].
9. Preparation time for the Summary and Final Rebuttal by both research teams[2 minutes].
10. 3 rd Researcher-Debater of the A research-team: Summary Rebuttal[2 minutes].
11. 3 rd Researcher-Debater of the B research-team: Summary Rebuttal[2 minutes].
12. Grand Cross-fire between the researchers-debaters (1 & 2) of both research-teams[3 minutes].
13. 3 rd Researcher-Debater of the A research-team: Final Focus Rebuttal [2 minutes].
14. 3 rd Researcher-Debater of the B research-team: Final Focus Rebuttal [2 minutes].
15. Final vote by the audience / Short written feedback [3 minutes].
16. Presentation of the results by the moderator [2 minutes].

If the debate takes place during extra-curricular activities, then it is recommended to devote, for example, 90 minutes for this part. This will allow you to prepare the room for the debate, recall the rules, conduct the debate and discuss its course and finally evaluate the work of students.

In terms of classroom conditions, it would be ideal to allocate two adjoining lesson units to the debate. Taking into account the school circumstances, organizational difficulties and the inability to devote too many lessons to content extending the core curriculum, the debate can be conducted in one lesson, while maintaining high discipline in time. In this case, it is recommended that during the next lesson with the classadditional 10 minutes are spent discussing the debate, pointing to strengths and mistakes made by the participants of the debate.

In this format, 6 students (3 from each team) actively participate in the debate. The teacher may also appoint a moderator from among the students and a time keeper. The rest of the students will receive worksheet number 3. Their task will be to listen carefully to the debate and to note the opposing team's strengths and areas for improvement, and to justify their choice. Completed worksheet no. 3 may be the basis for issuing a grade for activity in the lesson for students who did not take part in the debate directly, but participated in its preparation and were active observers of its course.

The projest has been funded with the support of European Commission within ERASMUS+ program

Worksheet No 1 – answers

FOR	„GREY AREA"	AGAINST
Can we imagine a world without bees? Bees are irreplaceable. Seventy percent of the crop species eaten by humans depend wholly or partly on pollination and recent estimates put the economic value of insect pollination at over £121 billion - representing at least 10% of the value of the world's agricultural production. *Why are bees important?* Bees are the most precious pollinators of plants. Pollination is an ecosystem service that is key to food security and wild ecosystems. Bees are essential for many fruit and vegetable crops, and the survival and spread of a large number of flowering plants. Sexual reproduction of many crops and the majority of wild plants is dependent on animal pollination through insects. Among the insect pollinators, solitary and social bees provide most pollination in both managed and natural ecosystems. *How would the loss of bees affect the world?*	*Are bees the only pollinators?* It is also important to remark that in many parts of the world, especially tropics, bees are not the main pollinators, but rather different species of birds, reptiles, bats, and even mammals serve this purpose. *Is it really true that bees are endangered?* Although from 2006 to date, the USA and some European countries reported severe loss of bees, beekeepers managed to make up for their numbers at the end of the year by dividing strong communities, which is a common practice in beekeeping. If 30-40% of bee communities disappeared every year, as was reported by the media, there wouldn't be any bees left today. The media often inaccurately and sensationally reported on the losses, in an effort to attract more readers, omitting the fact that beekeepers generally managed to make up for the losses by dividing strong and healthy communities at the end of the beekeeping season.	*Could the world exist without bees?* We don't have to imagine a world without bees because it actually exists. Located in an isolated part of the Southern Ocean, Macquarie Island is a UNESCO World Heritage site which emerged from the seabed approximately 600,000 years ago. The island has never been in contact with other land masses and is one of the most remote places on Earth.RMIT University ecologist and plant scientist Mani Shrestha said despite a limited color palette, the flowering plants on the island were diverse, hailing from six plant families found in Australia and New Zealand, including orchids. Macquarie Island is an extreme case which confirms that ecosystems can survive without bees. *What other pollinators are there?* Over 920 species of birds are known to pollinate plants including those belonging to the *Nectarinidae*(sunbirds), *Trochilidae* (hummingbirds), *Meliphagidae* (honeyeaters), and Loridae (lories). Birds pollinate about 5.4% of the 960 cultivated plant species for which pollinators are known and typically

The presumption of ample honey bees for crop and ecosystem pollination wasseverely challenged in the past several years by enigmatic declines of honeybeecolonies throughout the world.Due to the link between animal pollinators and global food security, any decline ofmanaged honeybees and the loss of wild pollinators are of increasing concern. *Would we starve without bees?* If you look at the plate of food on your dinner table, bees have played their part either pollinating the many vegetables and fruits we eat directly, or pollinating the food for the animals that we then consume. And that's not all bees do for us - honey and wax are two other important products that come courtesy of bees. *Does modern agriculture depend on bees?* Honeybees are reported to play a vital role in enhancing the productivity levels of different crops such as fruit and nuts, vegetables, pulses, oilseeds and forage crops. Fifty-two of the 115 leading global food commodities depend on honeybee pollination for either fruit or seed set. Some (five) honey bee-dependant commodities would have90% yield reduction without honey bees.		pollinate 5% of a region's flora or 10% of flora if that region is an island. Among mammals, bats are the major pollinators, with flower-visiting bats mostly found in two families: *Pteropodidae* (fruit bats), occurring mainly in Asia and Australia, and *Phyllostomidae* (leaf-nosed bats), distributed throughout the Neotropics. Approximately 528 plant species in 67 families and 28 orders worldwide are pollinated by bats. Non-flying mammals such as primates, rodents, and marsupials are also known to visit at least 85 species of plants worldwide. In addition, flower visitation is reported for 37 lizard species, mainly island-dwelling ones. *Are we in danger of losing other pollinators as well?* The loss of pollinating bats, for instance, would have major consequences for the reproduction of plants such as agave and columnar cacti, which yield high monetary-valued goods – mezcal and pitayas – in the Mexican agricultural market. Furthermore, durian (*Duriozibethinus*), which depends on bats such as flying foxes (*Pteropus*spp) for pollination, is an extremely popular and economically important fruit in Southeast Asia. *Are bees really endangered?* Bees are not even close to extinction, even in the parts of the world which report the biggest losses like the USA, because the number of hives was renewed every year by multiplying existing societies. Although from 2006 to date, the USA and some European countries reported severe loss of bees, beekeepers managed to make up for their numbers at the end of the year by

		dividing strong communities, which is a common practice in beekeeping. *Would the loss of pollinators jeopardize humanity and food supply?* The loss of all pollinators would reduce agricultural productionby an estimated 8% (from 5% (developed world) to 8% (developing world)). However, because many crops are not 100%reliant on insect pollination, some reduced production could becompensated for by increasing cultivated acreages. The loss of animalpollinators would require the developed and developing worldto increase land cultivated in pollinator-dependent crops by 15%and 42%, respectively, to make up production deficits. All of the abovementioned leads us to a conclusion that if bees were to go extinct, humankind would be able to survive and food supplies would not be jeopardized.

The projest has been funded with the support of European Commission within ERASMUS+ program

Worksheet No 2 – examples of argument– PRO

Argument with reasoning	Foreseen rebuttals of the other group	Answers to rebuttals
We cannot imagine the world without bees. The partnership between flowering plants and pollinating insects, especially bees, is one of the most widespread and significant symbiotic interactions on Earth. This 100million-year-old collaboration has spawned a rich diversity of species and promoted the rise to dominance of humans. Now the need to feed our burgeoning population, coupled with the agricultural means to that end – a plethora of pesticides, the unabated loss of natural habitat and the translocation of alien species and diseases - are driving wild and managed bee populations into a very steep decline. Seventy percent of the crop species eaten by humans depend wholly or partly on pollination and recent estimates put the	. We don't have to imagine a world without bees because it actually exists. Macquarie Island is an extreme case which confirms that ecosystems can survive without bees. It is also important to remark that in many parts of the world, especially tropics, bees are not the main pollinators, but rather different species of birds, reptiles, bats, and even mammals serve this purpose.	Bees are the most precious pollinators of plants.Pollination is an ecosystem service that is key to food security and wild ecosystems. Bees are essential for many fruit and vegetable crops, and the survival and spread of a large number of flowering plants. No other group of insects are of more benefit to humans than bees. More than one-third of the world's crops require pollination to set seeds and fruits, and most meat and dairy industries rely on bees for pollination of clover and Lucerne. Crops relying on bee pollination include apple, citrus, tomato, melon, strawberry, apricot, peach, cherry, mango, grape, olive, carrot, potato, onion, pumpkin, bean, cucumber, sunflower, various nuts, a range of herbs, cotton, alfalfa and lavender. The annual value of this service is estimated at US$112 billion worldwide.

economic value of insect pollination at over £121 billion - representing at least 10% of the value of the world's agricultural production.	There is a whole line of species whose influence on pollination is enormous, and whose survival is also in danger. They are unrightfully left behind and are an incomparably less important topic than bees, even though they are highly valuable for humankind, both as pollinators of crops and as guards of ecosystems in general.	Bee diversity is immense. There are more than 20,000 pollinating bee species in the world. Bees differ from many other providers of essential ecosystem services because they are often part of highly specific pollinator–plant relationships. Where there are very specific niche requirements for the plants and their pollinators, loss of the pollinator can have cascading effects across the ecosystem. For example, some bees that pollinate small herbaceous plants depend on holes in dry wood to nest, and when the wood is removed plant fecundity is reduced.
		Between1961 and 2006, agriculture industry's dependence on pollinatorshas increased by 50% and 62% in the developed and developingworld, respectively. This rate of increase surpassesthat of global increases in the number of managed honeybee colonies, suggesting that pollinators may limit production ofpollinator-dependent crops in the future.

The projest has been funded with the support of European Commission within ERASMUS+ program

Worksheet No 3 – examples of argument– CON

Argument with reasoning	Foreseen rebuttals of the other group	Answers to rebuttals
There is a whole line of species whose influence on pollination is enormous, and whose survival is also in danger. They are unrightfully left behind and are an incomparably less important topic than bees, even though they are highly valuable for humankind, both as pollinators of crops and as guards of ecosystems in general.	. Bees are the most precious pollinators of plants. Pollination is an ecosystem service that is key to food security and wild ecosystems. Bees are essential for many fruit and vegetable crops, and the survival and spread of a large number of flowering plants.	Located in an isolated part of the Southern Ocean, Macquarie Island is a UNESCO World Heritage site which emerged from the seabed approximately 600,000 years ago. The island has never been in contact with other land masses and is one of the most remote places on Earth.RMIT University ecologist and plant scientist Mani Shrestha said despite a limited color palette, the flowering plants on the island were diverse, hailing from six plant families found in Australia and New Zealand, including orchids. Macquarie Island is an extreme case which confirms that ecosystems can survive without bees. It is also important to remark that in many parts of the world, especially tropics, bees are not the main pollinators, but rather different species of birds, reptiles, bats, and even mammals serve this purpose.

		Over 920 species of birds are known to pollinate plants including those belonging to the *Nectarinidae*(sunbirds), *Trochilidae* (hummingbirds), *Meliphagidae* (honeyeaters), and Loridae (lories). Birds pollinate about 5.4% of the 960 cultivated plant species for which pollinators are known and typically pollinate 5% of a region's flora or 10% of flora if that region is an island. Among mammals, bats are the major pollinators, with flower-visiting bats mostly found in two families: *Pteropodidae* (fruit bats), occurring mainly in Asia and Australia, and *Phyllostomidae* (leaf-nosed bats), distributed throughout the Neotropics. Approximately 528 plant species in 67 families and 28 orders worldwide are pollinated by bats. Non-flying mammals such as primates, rodents, and marsupials are also known to visit at least 85 species of plants worldwide. In addition, flower visitation is reported for 37 lizard species, mainly island-dwelling ones.
		If we ask who is responsible for the production of grains in order to have sufficient amounts of food, the answer is certainly man.Namely, modern agricultural

	Bee diversity is immense. There are more than 20,000 pollinating bee species in the world. Bees differ from many other providers of essential ecosystem services because they are often part of highly specific pollinator–plant relationships. Where there are very specific niche requirements for the plants and their pollinators, loss of the pollinator can have cascading effects across the ecosystem. For example, some bees that pollinate small herbaceous plants depend on holes in dry wood to nest, and when the wood is removed plant fecundity is reduced.	production follows the development of seed material, artificial fertilizers, modern mechanization (tractors, other machinery), etc.thus confirming the responsible role of the human factor.The role of bees in the production of the most common foods in the human diet is almost negligible. The question is then how these plants reproduceif the bees do not act as pollinators.Hybrid species of plants, as well as grains, are reproduced with the help of man, that is, man "controls" which parental traits will be passed on to the offspring.As much as bees are given priority as irreplaceable pollinators and main food producers, the facts still speak differently.As the most represented food, the production of grains is still directed by the human factor.