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**Liquidation of diseases of Honey-Bees through Reproduction Regulation**

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# Foreword

Albert Einstein said that mankind would die out if bees disappear. This would be due to starvation because no yield will be produced by plants dependent on bee pollination. We would receive no crop without pollination. Bees are dying from infectious diseases. This is caused by weakened immunity from medications, especially from antibiotics. Further application of medicines will lead to complete extinction of honey bee.

***It’s impossible to imagine life of people without bees. We must stop using medications that destroy honey bee immunity. It is impossible to cure bees in separate regions or countries. Bees know no borders; therefore quarantine measures are not effective.*** This causes development of widespread and fast-spreading diseases. Disease development depends on the climate, vegetation, and other factors of bee colony life. For instance, tropilaelaps clareae cannot exist in high latitudes. These mites have a short life outside brood cell. Therefore they can be easily destroyed by creating a broodless period. Varroa mites develop poorly in dry regions of our planet. Foulbrood is less common in high latitudes. Wax moth is also rare in these regions.

***An innovative method of artificial (technological) reproduction regulation has been developed by the author. This new technology enables us to cure all known diseases of bees without medications.*** This method has been used in production since 2005. It is successfully tested on 20,000 colonies of bees. As a result, bee life span has been extended 10 times.

Such regulation allows us to lower expenses and increase profits. For this purpose, the author has invented and patented a special device – the queen isolating cage.

Also, life expectancy of varroa mites has been determined. This allowed development of a method for complete (100%) destruction of varroa mites in bee colony.

The author has described the possibility to release bees from varroa mites on the whole planet.

This new method allows producing bee products that are uncontaminated with medications.

It has been proven that this no-drugs treatment method helps to restore bees’ immunity.

It is predicted that the artificial reproduction regulation method needs to be applied in low latitudes as well. This will increase honey production volumes and improve bee health without medications.

A colony of long living, physiologically young bees have been obtained. It is resistant to varroa mites, nosema and other infectious diseases.

 This is only a brief list of the useful information in the book.

# Introduction

 Improvement of bee health on the whole planet is a new task. It arose from widespread varroa mites, nosema, foulbrood, mycosis and fast-spreading virus diseases. There are no means that would guarantee 100% recovery. Medications and especially antibiotics are applied spontaneously. Everyone uses different methods and schemes for application of drugs. New medications appear due to their low efficiency and habituation of pathogens. Their advertising looks like a fashion show. At first they show some effect and good response, and later - denial. Thus, the effect of drugs goes on and the bees' immune system is being destroyed. The first sign of it is appearance of chalkbrood. Later they got viral infections. This shows stages of immunity failure. Chalkbrood became massive and appears before viruses most likely because spores of this fungus are abundant in nature.

 It is interesting that if larva develops in optimal temperatures and is well fed, it can resist fungus successfully. Viruses are not as numerous as saprophytes, organisms such as funguses and bacteria that live on dead tissue. However, in favorable conditions they cause great losses in beekeeping, becoming more dangerous than other pathogens.

 Analyzing the health of honey bees on our planet, we can see that it is impossible to solve this problem regionally. A global approach would be needed. Each territory has specific characteristics that influence the beekeeping methods. Geographic latitudes play an important role as well. However, technological reproduction regulation can be applied everywhere. With some adjustments this method will be effective in all regions.

Timing for production operations is mainly influenced by geographic latitudes. It is important to take into consideration conditions in high latitudes of Northern and Southern hemispheres. Natural reproduction regulation is common for high and mid latitudes.

***Queens never stops laying eggs in low latitudes, except in instances of extreme drought. Therefore there is no natural reproduction regulation there. Technological reproduction regulation should be implemented in all regions.***

***Tests of this proposed method showed that it allowed improved health of honey bees, lowered the costs and increased profits in beekeeping.***

***The main condition, though, is simultaneous operations in neighboring regions.*** This means, that the regulation of queens' reproduction should begin within in short period (no more than 10 days). This should be agreed among beekeepers.

 A colony of long living bees can be formed when queen is isolated for 21 days. In this case it takes 54 days to obtain such a colony. Thus, long living bees will be born in 12 days prior to queen isolation, during 21 days of queen isolation and 21 days after. Thus, it takes 54 days to form a colony of long living and physiologically young bees. During first 6 days of queen isolation, a colony still has consumers of royal jelly. It will be produced by oldest bees and bees which were born 27 days before queen isolation. Thus, a mass of bees that never produced royal jelly will be created in 48 days (27 days before queen isolation and 21 days after). Six days of larvae presence will have an influence on creation of long living colony. However, 48 days of intense reproduction are very important and show possibilities of proposed method.

All these calculations show that colony of long living bees consists of bees that were born 27 days before queen isolation and 21 days during queen isolation.

Application of technological reproduction regulation allows us to improve bee immunity as well. A bee colony whose reproduction is managed does not produce excess generations of bees, thus allowing it to restore immune system and improve health.

It also allows us to obtain ecologically pure beekeeping products, which is important for the health of people.

Extensive application of this method will exclude the danger of polluted beekeeping products and eliminate the need for their testing. Difficult and costly quarantine actions will also be unnecessary. The low effectiveness of quarantine comes from the fact that bees know no borders. Thus, they do not help against massive communicable bee diseases. These include varroa mites, nosema, foulbrood and other dangerous diseases. Curing bees on the whole planet is difficult, but this is the only way to save their health.

Some diseases, typical for certain latitudes will be easier to cope with, but they always cause loses while bee colonies are recovering. It takes efforts, money and materials to treat them; pollination is performed poorly in this case.

 Thus, one of the first tasks is studying the proposed method for its useful implementation.

Life of people and many animals depends of yields of bee-pollinated crops. People and other living beings will die without bees.

This health improving technology, which does not apply medications, will help to restore bee health. It will guarantee our survival as well. Thus, ***it is vital to research, apply and develop this innovative technology. This will create conditions for survival of one of the best creatures on earth – the honey bee.***

Reproduction regulation should be deeply studied in all climatic conditions of our planet. Best ways of its use should be discovered. Researchers and beekeepers should share information on results of their work, which will help to discover new peculiarities of bee life and bring beekeeping branch to prosperity.

 Reproduction phenomenon research should stimulate studies of other unknown facts in bee biology.

 Among many thousands, more than a million species of insects living on our planet, honey bee is of the most interest to people. This insect is a symbol of diligence – “busy as a bee” we say. It pollinates entomophilies (pollinated by insects) crops, creating edible and healthy products – vital for human beings.

Diseases of bees have always been a focus of beekeepers, veterinarians and scientists. Jan Dzierzon described non-malignant and malignant forms of foulbrood. In 1885 Cheshire and Chain defined and described pathogens of European foulbrood. Academician Butlerov for the first time pointed out the necessity for disinfection against this disease in his work “Bees’ diseases – foulbrood” (1873).

Scientists and beekeepers have done a lot for prophylaxis and curing bee diseases, but we must note that not all modern methods and drugs can be recommended for the future. Above all we are talking about antibiotics. Their use should certainly be revised.

 They are not acceptable because:

1. Antibiotics destroy immunity;
2. Causative agents of diseases quickly become resistant to antibiotics;
3. Antibiotics contaminate beekeeping products which are consumed by people.

We should concentrate on deeper study of bee and bee colony biology, and reconsider use of medical and veterinarian drugs for treatment and prevention.

It is well known that strong colonies are resistant to pathogens of a disease. That’s why we say: “we should keep only strong colonies in the apiary”. Every beekeeper needs to know the proper conditions, required for the bees and maintain them. So to say: “work with all his heart”

So, it is important to understand, that to be a good beekeeper and expect to gain profits is possible only if bees are provided with everything they need and every colony has a high-quality queen.

In 1927 Cander, talking about a failing beekeeper, said: “The biggest enemy of the bees is a beekeeper”. That is why we should be attentive and active not to become one of them. It’s important to carry out rules and conditions, gain necessary knowledge and be obliging.

The experience shows that apiaries, where beekeepers are supplying colonies with everything they need, usually have less contagious and non-contagious diseases. These apiaries are highly profitable and rarely cause troubles to the owner.

Also it is noted, that some apiaries never have chalkbrood. That is achieved by keeping only strong colonies and constant microclimate stabilization.

 One of the most important characteristics of bees is their strong ties to entomophily plants. The plants are granting bees with their products – nectar and pollen. Bees are paying them back by pollination. This work is estimating yields of these crops. Absence of pollination causes zero yields, and therefore no food for people, which is a threat to their lives. ***Thus, pollination provided by honey bee has a direct impact on the future of mankind.*** To collect nectar and pollen, honey bee is using its whole body, including its hairy covering, which usually captures some pollen. So, by flying from flower to flower the bees are providing cross-pollination for the plant. The pollen is normally distributed among one variety of plants, because the bees are working on the same plant as long as it produces nectar and pollen. They switch to another one when nectar flow stops. This ensures stable pollination. Such characteristics of bee behavior are very interesting, important and useful.

Ever since people started keeping bees, they run into problems with their maintenance. Man relocated bees into gums and other simple hives, creating somewhat different living conditions, lacking constantly dry microclimate in the nest. This is explained by the fact that humidity on the ground level is higher than in tree hollows. Also, in first, simple hives it was not possible to take a bee nest apart. This problem was brilliantly solved by Ukrainian beekeeper and scientist Petro Prokopovich. However, ability to take bee’s nest apart has a negative impact when used by ignorant people. It is clear that beehive should be taken apart only when necessary and when it’s not harmful for the bees. Complete honey extraction is especially harmful to bees.

Let’s talk about supplementing honey with sugar. Honey is a high quality product, which meets perfectly all needs of a honey bee body. Sugar – is only energy source. Bees, eating sugar syrup for a long time, get weaker. All the interventions which damaged and weakened the bees' body and colony as a super-body, made it necessary to use medicine. At first sight they do seem helpful.

But later they did hurt the bees – by destroying their immunity. This caused more and more diseases to appear. First notable one was chalkbrood. Later, causative agents of pathogenic illnesses got stronger, and, finally, a number of infectious diseases went up.

This book describes methods for improving bee health that are based on its biology and natural reproduction regulation. They allow the bees to save food and increase productivity. Higher production of beekeeping products will be achieved if you consider adjustments to local conditions.

# Bee’s pathology.

Bees’ health problems may be caused by number of factors.

1. Pathogens of diseases and medication.

2. Physical, chemical and anthropogenic factors.

3. Nutritional deficit (individual or group).

4. Poor care.

5. Technological factors and lack of hygiene.

6. Poison.

As we know, a large group of causes for infectious diseases is called opportunistic. These include the ones that are provoked by pathogens, but clinical signs depend on living conditions of the colony. As a result, the disease appears in poor, or stressful, conditions.

Honey bees require life in large colonies, where its members are connected and mutually dependent. This applies to normal conditions and pathological events. Living in big colonies gives them an opportunity to store surplus of food, sometimes large enough to be useful in beekeeping production. A big colony is characterized by unity of opposites. Colony organization creates a super- organism. It can be damaged by pathological events with individual unhealthy bees or large number of sick bees. This process is recognized as colony disease.

It’s also important that illness of one bee is a threat to the others, and on other hand, the power of a colony as a whole is resistant to diseases. Because of this, super-organism has a characteristic of unity. It is named a bee colony. It has ethological immunity. ***This fact is based on the ability of bees to clean cells and other beehive elements. They are able to clean dirt as well as causative agents of disease. This results in self-purification and disease prophylactics, if the floor is away from the brood, as in tree hollow. This is especially true about brood diseases. For better understanding of all pathological events in bee colony, it should be viewed as one super-organism.*** In this case we can point out signs of unity, where functions are assigned to certain organs. For example: queen can be viewed as mobile reproductive organ, ovary, and endocrine gland (queen pheromones).

Honey combs – are a belly of the super-organism that stores necessary food. A colony with brood can be seen as a pregnant female. It is also interesting, that an individual bee is a cold-blooded creature, but a colony is able to regulate and stabilize its temperature, which is peculiar for warm-blooded. It has stable temperature thanks to mechanisms of thermo-regulation and thermo-generation. Genetically bees have the need to clean wax and other objects in the beehive. The super-organism has appropriate accessories, needed for fighting diseases. Each colony does this work in different ways.

It is also important to have sufficient space between brood and the floor so that the bees have no contact with dirt. This promotes hive purification and health improvement of the colony. Most pathogens getting into the hive fall to the floor immediately. The colony will stay healthy. These conditions were present in tree hollows where honey bees initially lived. Similar conditions we can create by placing empty boxes under the ones with brood.

Most of modern processes and means are not perfect, because they do not take into consideration general state of the colony and apiary. Not always we are focused on improving conditions, which help to increase resistance of individual bee and the colony.

Irresponsible veterinary medicine and beekeeping specialists are offering drugs for bees in the same manner as for mammals. This approach is not well-grounded. We should differentiate bee colonies, considering all the processes that take place there.

It is important to note that some medicine are used to treat people and animals but cannot be used to treat bees. Sometimes they are harmful and sometimes they are not suitable. For instance, antibiotics destroy bees’ immune system and lower their vitality.

To answer the question if the bees need any kind of medication, we should remember that honey bees previously lived in wild without any supervision from the people and mentioned above drugs. They lived and prosper. Drugs are not needed and harmful to bees and human health. People are forced to consume them with beekeeping products.

It is interesting to come to know the lifestyle of wild bees which they had before human interruption.

Ancestors of honey bees where characterized by hypobiosis (ability of newborn to survive in unfavorable conditions). Its loss was most likely caused by gaining the ability to regulate hive and cluster temperature. A main factor, which determined the colony life in some kind of shelter, became its ability to stabilize the temperature, which is usually higher that the environment. The situation, when it is required to generate warm temperature, forced the bees to move closer to the hive ceiling, the warmest place in the nest. Warm air is moving up, pushing cold air down. That is why **the foundation for bees home became the ceiling**, where bees would attach their comb and build it down. Such location had a main role in creating sanitary conditions in the colony shelter. Living on the ceiling, the bees are staying in the cleanest space. All the waste, dirt and even dead bees are falling down.

In the wild the bees generally choose spacious hollows, usually larger than the actual size of the colony. The comb is always attached to the ceiling.

 When the height of the hollow is greater than necessary, the unused space between the nest and a floor is used as a sanitary barrier. This barrier is getting bigger in taller hollows. Constant self-purification is protecting the bees from diseases, keeps them from contacting the waste, containing infections.

As a result of experiments, Gardi A. (1978) came to the conclusion that a colony would show no symptoms of American foulbrood, while the number of spores was less than 50mln. This level allows bee colony to clean the hive from dead larva. So, it is clear, that the larger is sanitary space, the more possibilities for self-cleaning and health improving the colony has.

Beehives with frames have no space to create sanitary buffer. For example, the frame in Dadant-Blatt hive is 30cm high, and a space between frames and the floor is 2-3cm. This beehive was created to be portable and efficient. The exceptions areLangstroth and Roje-Delon beehives, which allow placing an empty box under the one with brood, creating a sanitary space. However this possibility is not being used for now. Some beekeepers are using this method during wintering. The space under the brood is called air cushion.

While choosing habitation on their own, bees normally pick a location high above the ground. Vitvitskiy M. Wrote about this: “Elevated location of the hollow provided bees with drier air”. (Gurkov V.S. 1987). And here is a thought, mentioned one and a half centuries later: “(tree) hollows are better for honey production than gums”. These words belong to the senior researcher Ivniy Shafikov. He did consider the heights of beehive location. It is hard not to agree with him. This factor did allow bees to get away from excess moisture, which created higher comfort and had a positive effect on colony health, its development and productivity.

#  Barriers for infections

It is well known, that while leaving a colony, a swarm is flying substantial distances, sometimes tens of kilometers. In favorable natural conditions, wild colonies of bees are usually located far away from each other. This provides a colony not only with sufficient supply of nectar and pollen, but also stops spreading of diseases. In this situation there is no roaming and stealing between the neighbors. That protects them from infections, since the contacts between the colonies are rare or even impossible. Also, such settlement ensures better use of nectar and pollen sources and therefore more even pollination of entomophilies plants.

Considering the fact that pathogens of diseases are destroyed by physical factors such as solar radiation, drying up, etc., it becomes clear that sufficient spacing between the colonies of bees is very important – it is vital for their survival as a species.

Bee colonies with sufficient nectar and pollen sources can collect enough honey for their health and well-being. This strength gives them an opportunity to create sufficient stock of food for wintering period. Weaker colonies would not survive the winter, which created natural selection of stronger, more productive bees.

Wild colonies usually would not use wax combs of perished colony. It is well known that more often a colony dies during wintering. And colonies do not change their location in the spring time. In the summer heat deserted wax combs are destroyed by wax moth, bears, martens and other animals. Thus, if the colony died due to an infection, it wouldn’t spread to other bees’ colonies.

Most infections cannot be spread while drones and queens are mating. Drones are appearing only in strong colonies. Queens are also raised in strong healthy colonies, while preparing for swarming. Weak colonies sometimes produce emergency queens, but this is a rare event. Besides, drones that impregnate queens die immediately. Thanks to that he cannot transfer infection to another colony.

All the facts, mentioned above make it clear that the bees existed without human support for centuries. So, most diseases are a result of modern beekeeping technology.

Analyzing wild bees’ lifestyle helps to understand that we should use no-drugs methods, appropriate for prophylactics and treatments of bee colonies, since they survive in the wild without any medicine.

# Infection mechanism

Contagious diseases of bees have a tendency for spreading and new ones appear. Some apiaries are struggling with several diseases at the same time. One of the reasons for that is same location for large number of the colonies. That promotes drifting of bees between hives and robbing behavior, which spreads infections.

Limited beehive space, which is occupied by the colony during the most active period, also helps spreading the diseases. This takes place because the waste from colony activities is in the constant contact with the bees. Small parts of dirt are sticking to the legs and hairs on their bodies and move around.

Moving frames from one colony to another also can cause infections growth.

Transportation of package bees and queens, moving apiaries while changing owners or for harvesting honey can also result in infecting other apiaries.

Diagnosis of diseases in apiaries is often late due to the lack of symptoms knowledge.

Veterinary services are not always effective in localization of infections because of insufficient information about causes of diseases. Disorders are usually discovered only after clinical signs of illness appear. This creates a situation when it can be allowed to transport infected colonies, packages or queens to other apiaries. The quarantine rules for just arrived colonies are rarely met.

# Contamination as a cause of infection

In a sick colony everything is infected, including walls, frames, and combs. Each cell can contain an infectious cause. If a queen will lay an egg in such a cell, the larva can get sick if such infection causes brood diseases. However, this is not always the case. It will not happen if a larva has immunity. Larva can get in contact and even swallow spores of chalkbrood, but if it is warm and well fed, it might not get sick. The larva will stay healthy, and swallowed spores will be digested just like other food. With a traditional technology it is very hard to achieve complete disinfection of all combs. But a technology of artificial regulation of reproduction gives such opportunity. Besides, while cleaning all the objects in a beehive, including combs, bees are creating waste, which is a source of infections. Lack of space under the frames creates circulation of infections inside beehive. That is the main reason for most stationary illnesses of bees. Such situation creates conditions for bees’ contamination.

# Problems with treatment of bees

Let’s talk about main principles for treating foulbrood, sack brood and mycosis.

Brood diseases usually develop in early stages of bee growth. All of them cause decline in young bees’ number. Sometimes they lead to death of larva, prepupa or pupa. This weakens greatly a whole colony.

Sulimanovich D. (1980) discovered that American foulbrood is one of the most dangerous diseases of bees, which is now registered in all parts of the world. In 1827 Prokopovich reported for the first time about foulbrood in “Agricultural magazine” № 19. He wrote that foulbrood is transmitted through wax and honey. Bees and a queen, kept hungry for two days away from the hive, stay healthy.

Foulbrood can be destroyed in only one way – by moving the bees to another beehive, where they are placed after two days of hunger. That is done not to allow the bees to move some contaminated honey to the new hive.

Georgievsky (1936) offered an original method for treating the colony against foulbrood. He suggested installing empty combs into new beehive along with foundation. One day after transferring the bees the comb with contaminated honey would be taken away, preventing the colony from spreading foulbrood.

 While treating the bees against chalkbrood, Bobov V.D. (1987) suggested taking away frames with infected brood, transferring the colony onto disinfected foundation, disinfection of combs, beehives, magazines, and other beekeeping tools.

Similar methods were suggested by Solovyeva L. (1986). Olenevsky (1989) recommended to move infected with chalkbrood colonies, removing brood, changing queens, providing better insulation and placing beehives in sunny spaces. Gartvig А. (1981) besides changing hives recommended to clean floors, reduce laying eggs by the queen, destroy infected combs. Smirnov A.M. (1980) discovered foulbrood pathogens not only in honey bee, but in larva of flies, wasps, wax moths and cudweed.

Temnov (1938) noted the possibility of spreading foulbrood through infected artificial foundation. Wax is melted at the temperature of +75° - +85° С, which does not kill foulbrood.

Considering this, it is recommended to heat wax, obtained from apiaries that have foulbrood, up to +127° С and 2 atmospheres pressure for 2 hours. Similar conditions are required to treat wax contaminated by chalkbrood and European foulbrood. However, this method of disinfection damages the structure of wax, making it unsuitable for foundation production. Also it causes 2% of wax to burn down. Nowadays chalkbrood is so widespread, that almost all the wax needs to be disinfected.

That is why it is required to decontaminate all the wax in foundation production. The Institute of Prokopovich has developed an effective way to purify wax without destroying its structure. This method was invented and patented by Khmara P. and Bondarchuk L. they can provide further consultations regarding this technology.

Careful study of treatment methods against foulbrood, sacbrood and mycosis shows that the nature of pathogens and their resistance is not deeply understood yet. Shortcomings of modern treatment methods are: inability to disinfect all the combs at the same time and prevent bees contact with pathogens on the hive floor, as it used to be in the tree hollow. We should pay attention to a hidden process that was distinguished by Kinchev, Lutskanov and Arsenov (1981) in apiaries damaged by American foulbrood. It results in relapse and infection expansion. Widely used treatments against diseases provoke infection transmission from clinically healthy colonies. Virus of sacbrood stays in the fat cells of queens, which was discovered by Nunamaker R.A., Nunamaker N.E and Vilson V.T in 1985. It is very important factor for illness spreading to also replace the queen along with other treatments.

All the activities, improving brood health need to be supported by separation of bees and beehive floor, as it works as a preventive measure.

Also, it is important to include wax purification in a list of prophylactics measures; using technology developed by beekeeping Institute of Prokopovich.

# Factors causing bees diseases

Any lapse from a norm in a body of a worker, drone, queen, their larva or pupa, or a super-organism – bee colony, should be considered a disease. The disease appears in conditions that are sub-optimal. These can include temperature, humidity, lack or poor quality of food, lack of water, microorganisms, and weakened immune system of the bee.

When all physical conditions are close to the norm and there are no pathogenic microorganisms, then no disease will appear. In some colonies even a substantial number of microorganisms dooes not cause sickness, while in other colonies it does.

Depending on the presence of pathogenic microorganisms and parasites, diseases are divided into contagious and non-contagious. The main criterion of contagious diseases is availability of the causative agent and its ability to pass from one bee to another, and from colony to colony. Non-contagious diseases can have number of causes: from natural factors to beekeeper’s actions.

It is well known that before humans started interfering with bee colonies there were less contagious and non-contagious diseases. The main threat to the bees at that time was hunger that occurred during years when the bees couldn’t store enough food for wintering. Contagious diseases were less common because there were no conditions for them. First of all, the bees were spread out more sparsely on favorable territories. Therefore, contact between colonies was less common than in modern apiaries. That stopped pathogens from spreading.

Wild bees lived in shelters which served better for sanitation and disease prevention. Food stock in wax comb was completely consumed during the winter. Brood location in the upper part of the nest and essential space under it were important factors for keeping it clean. All this helped to keep infectious diseases down.

Consideration of conditionally-pathogenic causes is important because a contagious disease does not develop in conditions favorable for bee health. This point shows the importance of non-contagious illnesses and makes it necessary to analyze their possible causes and mechanisms of development. That is why we need to see the connection between non-contagious diseases and bees’ ability to resist them. For example, during the early stages of protein dystrophy, the bee body is more susceptible to nosema, chalkbrood, foulbrood and other illnesses. This can be halted by timely feeding additional bee bread, pollen, or their substitutes: dried or skim milk, yeast, or soybean flour. Receiving the most valuable product, bee-bread, will ensure good health and further colony development. It’s important to remember that colony death from starvation can take place in winter time if there is not enough honey for the cluster.

Nectar poisoning is a disease that is hard to predict. It occurs when the bees are forced to pick nectar from poison plants, when ordinary plants have no nectar due to dry, cold or rainy weather. This situation can be improved by feeding the bees with sugar syrup (1:1, half a liter per colony per day, for a period of such nectar presence). This additional feeding will support the colony during a difficult period and lower the concentration of poison in their food stock.

Salt poisoning, on the other hand, is completely a beekeeper responsibility. It may take place if the bees will obtain water with more that 0.5% salt concentration. Concentration of more than 2% of mineral fertilizer in water is deadly to the bees as well. This includes poisoning the bees by pesticides and pollutant emissions. As we remember, approximately 20 thousand bee colonies died in Tismenitsk, Nadvirna, and Ivano-Frankovsk regions in 1992. This happened because dry low winds and hot weather remained for 2 months. Industrial emissions accumulated on buildings, land, trees and plants. Later, strong wind concentrated the poison in fenced, wind-protected, places where apiaries were usually located. This resulted in a high poison concentration in apiaries. In Pavlovka village even fish in a small lake beside apiary were poisoned.

Beekeepers should always insulate beehives to prevent chilled brood, especially in the spring. Also they should be careful not to overheat the bees while moving them to other locations.

It is vital to understand that management mistakes cause higher losses in apiary than infectious diseases. Therefore every beekeeping operation should be done well and timely, even though there is always not enough time. Constant attention and diligence will help to avoid most problems at the apiary.

It happens that some colonies do not get sick and have no clinical changes when exposed to pathogens of certain diseases. Beekeepers, veterinarians and scientists are interested in this phenomenon. This can be explained by resistance the colonies have against certain illnesses. It’s important to understand a difference between infection of super-organism and its components: larva or an adult bee.

It’s well known that an infection is an interaction of micro and macro organisms. There is a winner and a loser in this process. When the macro-organism (bee) wins, it does not get sick even after being infected. Virulence (aggression) of the micro organism needs to be considered as well. That means its ability to overcome immune mechanisms of macro organism. On the other hand, infectious processes are characterized by macro-organism resistance where its body strength allows it to withstand infection. This power should kill causative agent of a disease or stop its development, which prevents the pathological process. When a microorganism cannot overcome the defense of macro-organism, no disease is developed and pathologies do not appear, or they are weak and hidden.

We should remember once more that in natural conditions feral bee colonies do not get sick very often, whereas bees in apiaries have exhibited more and more diseases in recent decades (especially foulbrood). This is partially explained by varroa presence. Varroa mites feed on the blood plasma of adult bees and larva. They bite through the external cover of the bees’ body. These wounds become “gates” for infections. Thus, mites are accelerating the spread of infections. Therefore infectious diseases appear more often and on the larger scale. Viral illnesses are especially prominent lately.

Treating foulbrood with antibiotics was effective at first. Now they are massively used not only for curing, but as a prophylactic as well. ***Continuous use of antibiotics allows for habituation of microorganisms, and therefore lowers the effectiveness of medications and destroys bees immunity.*** Application of organic acid against varroa also worsened bees’ immunity. Additionally, organic acid can prolong mycoses by exposing bee colony to fungal infections. Considering all mentioned above, we can say that beekeeping practices and feeding methods can contribute to the growth of contagious diseases in bee colonies.

Keeping only strong colonies in an apiary is a very important statement and should be further emphasized. Strength of the colony is significant because it keeps all the microclimate parameters at optimum and brood is always well-fed. Bees from a strong colony fly further and can carry more weight to serve their brood better. In the winter each bee in a good colony consumes less honey, which prevents its guts from overloading. The bee wears out less, which means it is physiologically younger, because it saves more protein compounds.

In contrast, in a weak colony everything is vice versa: bees consume more honey to maintain a comfortable temperature, their guts are overloaded, and the amount of protein compounds in their body goes down since they are used to break down honey. These factors result in premature aging of the bees. Thus, the main reason for bees aging is mainly caused by protein deficit.

A strong colony is more productive. It develops faster, creating more brood space with a stable temperature for the queen to lay eggs. Apiaries made of strong colonies exhibit less sickness. It is also important to have only high quality queens, able to lay a lot of eggs.

Beehives should be well maintained. An apiary needs to be supplied with adequate number of combs, which should not be re-used for more than two years. Therefore one third of all combs have to be built and replaced every year. A sufficient number of drinking dishes needs to be at the apiary, especially in the spring time when bees need water to prepare food for larva.

Let’s imagine an ideal situation where there is a drinking dish with warm water (warmed up to 30°С at most). A bee receives water near the beehive. Such conditions allow the bee to be highly efficient. But, if there is no drinker at the apiary, the bee would have to fly to the nearest pond with cold water. Consuming this cold water can make it chilled and unable to fly. In this case larva is left unfed and the colony gets weaker.

To have enough food for brood, an average colony needs at least 6-8kg of honey at all times. That amount enables bees to feed larva and develop fast. Insufficient honey slows down the colony growth. In situations where there is not enough honey, sugar syrup should be fed to the bees. A colony cannot feed brood without bee bread, a universal product comprising protein, fats, carbohydrates, mineral salts, vitamins, microelements, etc. However, if needed, bee bread can be substituted by yeast, soybean flour, or dried skim milk.

The optimal characteristics of beehive microclimate are a temperature between 34.5° and 35°С and 60-80% humidity. These conditions can be met in good beehives with proper insulation that can protect the bees from low and high temperatures.

It is worthwhile to perform selection of highly disease resistant queens at the apiary. A strong colony can resist chalkbrood thanks to its power, if not heredity. When clinically healthy colonies are identified in an infected apiary, the weakest one of the healthy colonies is most likely to have genetic resistance. The strong ones can overcome the disease by maintaining a stable microclimate, which protects even non-resistant larva.

#  Infection and immunity

An infectious process is a complex biological phenomenon, when a harmful microorganism enters and spreads inside the honey bee body. It feeds on tissue and blood plasma, weakening the bee. The bee’s reflexes turn on its protective system that is designed to eliminate pathogens. The result of confrontation between pathogens and the body is highly influenced by environment conditions. In favorable conditions bees are significantly resistant to the bacteria.

Development of an infectious process depends on the type of bacteria, their number and virulence. The same factors influence its specificity. For example, Nosema apis causes nosema, Bacillus larva spores provoke American foulbrood, etc. The number of pathogens also matters. No less than 10 thousand spores of Bacillus larva are needed to infect single larva, and at least 50 million of same spores are required to hurt a colony of bees.

The virulence of a causative agent is its ability to live and multiply in the macroorganism, overcome its protective mechanisms, create toxins and affect tissues of the adult or larval bee body.

In case of epizootic and massive death of larva, virulence of microorganism is increasing. For instance, the agent of European foulbrood is more virulent after passing through larva bodies.

An infectious process in a colony of bees is measured by the number of sick bees and larva, and pace of its growth. With only a few sick bees and weak disease development, the colony will not look ill. This form of disease becomes a reserve of pathogens and will turn into destructive disorder if conditions worsen. When most bees and larva are sick, the colony is diminishing fast and can be easily observed.

The character of illness development can be a hidden, dormant or explicit form. In the first case, viruses are detected in food stocks (honey, bee bread), on the combs and other parts of beehive. The pathogen is in constant contact with the bees and larva, can penetrate their body, causing possible immunobiological body alternation, even without notable functional disorder. During the winter, when the temperature in the cluster is lower than 34°С, bees do not get nosema because regeneration of midgut epithelium of the bee is fast, and the parasite is developing slowly in unfavorable conditions. According to the studies of Baumgartner (1938), mature larva can get European foulbrood but not die from it. This is an example of a hidden form of this disease, when it is impossible to observe by normal visual inspection. This form is sometimes called dormant because when bee colony faces difficult conditions the disease can reach its explicit form.

An explicit form of an illness is characterized by weakening of the colony and its lag in development. Thus, in cases of European foulbrood, we typically observe death and rotting of larva aged 3 to 4 days; pollen poisoning shows mass loss of young bees, etc.

An illness can also have a light form, when its symptoms are weak, and infections or invasions can only be discovered in the lab.

Hidden forms of various diseases are common for the bees. This takes place because it is difficult to isolate infected colonies from healthy ones.

# Immunity

Immunity – is an ability of the body to resist infections. Adult bees and larva have immunity against microbes or their waste products. There are inherited and acquired immunities. Inherited immunity appears at birth and is inherited together with other morphological and physiological signs. In contrast, acquired immunity appears after being ill or as a result of immunization by certain biopreparation. Acquired immunity is also called specific, because it works against certain disease.

Inherited immunity of the bees is non-specific. It protects them from number of infections. However, it does not work against most dangerous illnesses. Inherited immunity is supported by internal and external mechanisms. Protective factors include body covers of adult bees and larva. Top body cover of the bee is a very strong polysaccharide – chitin.

Body covers provide not only mechanical protection, they secrete active substances that are highly antibiotic (Lovi, 1960).

Internal protective mechanisms are formed by blood corpuscle, hemolymph plasma, fat body and others. Blood corpuscle of hemolymph is called hemocyte (blood cell).

The structure of corpuscles of adult bees is not constant. It changes depending on age, body condition, season, microflora in hemolymph, and medication.

For bees that are born in spring and in the beginning of summer, maturing and ageing of hemocytes is slower than for the bees born during the end of summer and beginning of fall.

Hemolymph of wintering bees sometimes contains microbes, and their number increases towards the end of winter. These microbes disappear after spring flying.

Medications affect the size and fission rate of hemocytes. Under the influence of antibiotics (biomycin, synthomycin, penicillin and streptomycin) the size of hemocytes decreases by half, fission rate triples because of penicillin and streptomycin. Fission rate becomes six times higher when biomycin and synthomycin are applied. Kopanevich (1965) demonstrated that small doses of antibiotics stimulate life support processes, but larger amounts slow them down. Accordingly, depending on the dosage, young bees’ life can be prolonged or shortened.

Body fat also plays an important role in protecting bee body from infections.

Bees have well developed protective mechanisms that defend them from infections and invasive disorders. Brokert (1956), Lavrehin (1958) and Riordan (1958) described so-called biological treatment method. It is based on creating favorable conditions for the bees, including sufficient pollen and honey supply, and feeding enough carbohydrate and protein. These factors have a good impact on colonies development and protect them from nosema and amebiasis. However, these factors have no effect on American foulbrood and tracheal mites.

# Age-related immunity

 This immunity type depends on the age of a bee. For example, an egg is resistant to many infections and illnesses. Larvae never endure nosema, tracheal mites, amebic dysentery, but are subject to American and European foulbrood, sacbrood, chalkbrood, and aspergillosis.

Unlike larva, adult bees can suffer from nosema, amebic dysentery, tracheal mites, paratyphoid, and septicemia. Varroa mites involve bees at all development stages, except the egg.

# Specific immunity

People have tried to create immunity artificially, so called acquired immunity. It is a result of vaccination. Vaccination of bees is desirable but laborious. The most active season for bees is very short, and they only live approximately one month as an adult. Daily birth rate during this period is high, which means a vaccine must be applied often. That is why this method is not widely used.

# Bee colony, immune to diseases

Colonies of bees that are resistant to foulbrood have been developed through selective breeding. Half of the selectively bred colonies did not become diseased after being artificially infected by inserting diseased brood frames inside colony. The disease was found in some colonies, but disappeared shortly after. This resistance can be explained by their ability to remove dead larva quickly from the comb. Therefore, ability to withstand infectious diseases should be used as selection criteria.

# Ethological immunity

One of the most important behavioral characteristics of bees is their ability to thoroughly clean wax combs and other parts of the beehive.

A colony of bees will initially occupy upper (the warmest) part of the hive. This location allows them to create comfortable microclimate conditions for building comb, storing honey and raising brood. This happens simply because warm air rises and collects under the ceiling. Everything in the beehive starts from the ceiling: building comb, first honey storage and other vital functions. Thus, we can say that the ceiling is a foundation for bee habitation. During beehive cleaning all the dirt and bacteria are falling on the floor. When the floor is distant, the bees never walk there and it helps colony sanitation and curing. It is a natural prophylactic action for healthy colonies.

Proper use of ethological (behavioral) immunity requires sufficient space between beehive floor and lower part of the nest, to prevent bees’ contact with waste. In modern beekeeping practices this can be achieved by placing 2-3 Langstroth boxes under the boxes containing brood.

# Etiological classification of diseases

Etiology means cause, or reason. Etiological means causal. This classification enables us to diagnose properly, define treatment and preventive methods. Diseases of bees may be classified as *invasive*, *infectious* and *non-contagious*:

***Invasive***

This group of diseases is caused by animalcular multicellular organisms or parasites: Tracheal mite, Асаrарis mite, Varroa mite, Pyemotes mite, Tropielaps clareae, Conopidae fly, Meloe bugs, melitobios, Braulidae fly, Senotainia fly, Stylopsosis, Phoridae, Nosema, Microsporidia, Eugregarinidae, Crithidia apis, Nematomorpha.

***Infectious***

These diseases are caused by microbes and viruses. They include: American foulbrood, European foulbrood, chalkbrood, foulbrood caused by Вас. Paraalvei (false foulbrood), pollen posioning, sacbrood, chronic viral paralysis, acute viral paralysis, filamentovirosis, other virosis, chalkbrood, aspergillosis, melanosis, candidosis, other mycosis, hafniosis, colibacteriosis, salmonellosis, and septicemia.

***Non-contagious***

This group consists of pathologies caused by poor nutrition (lack of carbohydrate, protein dystrophy, hypovitaminosis), lack of other nutritious components, alimentary diarrhea, saline posioning, phyto-posioning, honeydew posioning, poisoning by mushrooms, plants, pesticides and industrial waste. Also, non-contagious diseases can result from operational shortcuts such as theft, cooling off, chilled brood, overheating, and nanocormia. Physical factors can cause pathology as well. Poor beekeeping practices can result in hereditary diseases and embryo pathologies, sterile eggs, black eggs, poor egg laying by the queen, genetic mortality, malformation of pupa, diploid drones, pathogenic queens, bodies anomalies and nanocormia.

# Beekeeping technology and bee’s diseases

The number of diseases and ill colonies has increased in recent years. It is interesting, that the same disease-causing microorganisms we have today, lived side by side with wild bees, and were not able to break through their protective mechanisms and infect their bodies. For example, Ascosphaera apis (chalkbrood). It is one of the oldest inhabitants of the planet, and was not harmful to bees for many centuries. That is why we should remember one of the rules of the infection process: in the interaction between micro and macro organisms, the disease does not appear when macro organism wins. This is possible when the bees live in comfortable conditions for many generations, having stable temperature in the beehive, enough food (carbohydrate and protein), and appropriate sanitary situation. Temperature balance is greatly influenced by colony size: “heat, generated by the bees is used more effectively in larger colonies”. In this situation a bee is not overworked generating heat. Also, there are better possibilities for nectar and pollen collection in larger colonies. Normally, stronger colonies have more food for development and reserves because they have more bees to collect and deliver food. The percentage of forager-bees in a colony increases as the colony grows. That is why stronger colonies are less sensitive to diseases caused by opportunistic agents. Naturally, we should consider keeping only strong colonies at the apiary. It is well known that in a weak colony bees have a hard time trying to stabilize temperature in the winter, expending too much energy on this work and consuming too much honey. As a result, the bees in weak colonies wear out and age physiologically faster. This phenomenon happens due to the large amount of carbohydrates needed to generate heat, which requires use of enzymes – protein compounds. This surcharge of proteins destroys vital body systems, thus shortening their longevity. Additionally, it speeds up filling of bees’ guts, which can provoke diarrhea or defecation inside the winter cluster.

In weaker colony bees are usually less resistant to disease and more physically weakened, and thus they cannot work as much as healthy bees.

Anthropogenic products also have a negative impact on bees. Thousands of bee colonies have been killed by chemical emissions from industry and other harmful pollutants.

Another unfavorable factor destroying bee immunity is overuse of antibiotics, especially for disease prevention.

Application of organic acids against varroa mites is also hurting bees’ endurance, and can be a cause of immunity loss.

Beekeeping practices, especially splitting colonies, can destroy their ability to stabilize the temperature in the nest, enabling pathogens to intrude and grow into a disease.

Constant replacement of honey by sugar can result in gradual colony dying out. It affects immune system as well.

Permanent contact of bees with dirt and bacteria on the beehive floor becomes a burden for the colony, and increases its likelihood of becoming diseased.

All mentioned above factors have an impact on bees’ disease resistance. It is important to ensure proper delivery of food for the colony, which greatly helps their welfare.

***Rejecting medication and use of technological breeding regulation will improve bee health and ensure a gradual restoration of natural immunity to disease.***

# Solving diseases problem

 Productivity is one of the most important measures in beekeeping. It consists of obtaining honey, wax, pollen, royal jelly, bee colonies, queens, swarms, and nucleus colonies. The most profitable activity is pollination of entomophilous crops. This function is perfectly done by bees and makes them irreplaceable. Many crops would have zero yields without pollination.

Reproduction is a fundamental aspect of bee colony life. Regulation of this important process has not yet been studied, thus is not among beekeeping tasks. No one even thought of creating a **method for technological reproduction regulation.** Targeted regulation or cessation of reproduction can be beneficial in many cases, such as swarming prevention. This method is useful for saving food and creating desirable conditions for bees. It may be successfully applied to prevent development of infections and brood diseases. The idea is to eliminate reproduction of many generations of bees, and maintain long-lived ones instead. In this case, the colony has an opportunity to live for a certain time without brood during inactive seasons, therefore eliminating food waste. During such period there is no need to produce royal jelly, which would otherwise speed up aging of individual bees and a colony. Thus, there is a chance to save resources and support bees’ **physiological youth**.

 When reproduction is stopped, a colony of bees is still a working biological unit. Aging is slowed down, therefore life expectancy is higher. This is true for each individual that belongs to a super-organism – bee colony.

The bees, which appeared after reproduction process was stopped, do not secrete royal jelly for brood feeding. They become a long-living part of the colony. It is reasonable to stop reproduction when no active nectar flow is expected. That is a period when bees need to make stocks of food for winter. Colonies, having no brood in fall and spring (when nectar flow is low), survive better through winter, develop faster in spring time and produce more. In territories where a nectar flow takes place only in early summer, it is worthwhile to make winter stocks right after nectar flow, and then stop reproduction.

This work is aimed to get positive effect from reproduction regulation. ***The purpose of reproduction regulation is improvement of bee health while using efficient and profitable technology.*** This statement is grounded on use-proven facts.

# Some detail of bees reproduction

It used to be considered that larva is born from an egg by breaking through its coating. Khmara P.Y (1975) showed that the coating of an egg is lysed – melted down by enzymes that become active at the proper time, beginning the birth process. It is apparent when magnified by 20-40 times under a microscope. The coating becomes lighter, gradually making the larva visible. Later, a drop of liquid appears on the top of an egg where larva head will show. This means that there is a hole in the front part of an egg. Lysis goes on until the larva is completely free from the coating. Contact with royal jelly during this period is deadly to larva. It dies from asphyxia – suffocation, because its tracheal system is filled up by liquid (drowning). This occurs because capillary space between larva and coating is filled up by royal jelly instead of air. Therefore, bees do not feed royal jelly to larva until it is completely free from coating, and larva is lying on the bottom of a cell without jelly. These cells with just-born larva seem empty. Larva can be seen only using 5-10 times magnification. Some studies showed that larva lives for about 4 hours after getting out of an egg. Newborn larva is somewhat smaller than an egg, its body is light (milk color) and transparent, making it difficult to see without microscope.

Not all reproduction mechanisms have been studied. A process which defines gender of an egg was described by Khmara P.Y. (1975). Main role in the process belongs to queen’s ovipositor. When it touches the side of a cell while laying egg, it causes sperm to go out of spermatheca. In this case the egg is fertilized, diploid (diagram 1). Feminine larva will be born from it, which can become a worker bee or a queen. The process looks like this: the queen drops her abdomen in a cell, making the ovipositor touch the cell wall. This contact causes an impulse to start sperm release on microcapillary part of an egg. While in larger drone cell, ovipositor does not touch the cell wall, and the sperm releasing mechanism is not activated. In this case an egg is not fertilized, haploid, male (diagram 2). A drone will be born from such an egg.

 Diagram 1: The process defining an egg gender:

 ♀♂ ♀

 а) b) c)

а) Diploid egg - female; b) Haploid egg - drone;

c) Diploid egg – female, in queen cell for raising new queen.

The queen cell is the largest cell type, but queen is bending its whole body making the ovipositor touch the cell. Thus, the sperm releasing mechanism is turned on, and the egg becomes fertilized.

Reproduction of bees is one of the most important processes in beekeeping. Knowing its peculiarities and rules can help us create an efficient system for bees’ sanitation and profitable beekeeping production.

Brood is important for all aspects of colony life. There are unknown mechanisms in this process and therefore they are not considered and managed. Some of them are studied by scientists but have not been used for production improvement.

Reproduction is regulated by seasons. In middle and high latitudes, reproduction stops during the cold season. In low latitudes, closer to equator, such seasonality does not happen. Time without brood is very short or non-existent there. On the average, bees live about 35-39 days in a colony with brood. Their potential longevity is more than a year (according to Mauricio, 1958). However, most factors that shorten bees’ life take place in the active season.

In the dormant season, when there is no brood, bees live longer, reaching their potential life expectancy. Their lives shorten with brood appearance. With brood present, worker bees age fast and live no more than 35-39 days. This phenomenon is explained by necessity to produce royal jelly, which uses up protein compounds of bees body, and the protein deficit leads to their death. Protein substance is given to a bee only during its larval stage. Used proteins do not restore. Thus, physiological aging is related to protein substance use. Proteins of bees’ body are also used when digesting sugar syrup. It is a difficult task for bees, because enzymes, which are used to break up disaccharides sucrose, are also proteins, taken from bees’ body. Therefore, this task has to be done by a bee that is not expected to have a long life. Considering everything mentioned above, we can make a conclusion: brood should not be in a colony in late autumn, winter, and early spring. The best time to stop reproduction is mid July, when nectar flow is low This is true for locations in mid-latitudes, for example 50° of northern latitude, where Kiev is located.

As an experiment, on the 7th of July in 2004 reproduction of bees in a hive was stopped by caging the queen. On the 28th of July the youngest bees and varroa mites were born. The colony lived on 7 frames of Dadant-Blatt beehive (frame size 435 х 300mm.). By this time, a winter stock of honey was mostly formed (partially from nectar, and partially from beet sugar). During the first days, having young brood, no queen cells were formed. Thus, the bees had a good contact with their caged queen, and did not feel orphaned. This would certainly happen if the queen would be placed in Titov cage. Bees were able to lick off plenty of queen pheromone. The queen could not lay eggs, but it’s presence in the colony was obvious. The main objective of the process was reached successfully: young bees did not have to feed brood with royal jelly after 3 days. This allowed them to live a longer life, compete with varroa mites, and outlive them. This gave them a chance to get rid of varroa mites. The author calls these bees long-living and physiologically young. The ones that had to feed the brood with royal jelly and lived 35-39 days are called short-living bees. The above-mentioned colony had its queen released on the 16th of April of the following year. The colony still covered 7 frames, which means that the bees that were born after queen isolation, became long-living and the colony did not get any weaker.

It’s important to note, that the colony with its queen isolated in a specially designed cage is no different from any other colony, except for the brood presence. This state is reached in 21 days after queen isolation without drone brood and in 24 days with drone brood. This allows regulating reproduction of bees due to production needs and consideration of existing circumstances.

 Ability to stop reproduction in 2-3 weeks before nectar flow ends becomes especially useful in mid latitudes (Kiev region for example). Three periods for terminating reproduction have been tried there: July, August and beginning of September. All of them showed positive results. This proves that process of laying eggs can be stopped during active season. It’s important to understand, that ***brood that is left in a colony after queen isolation will grow to be physiologically young and long-living bees. A colony needs to be healthy during the period of queen isolation. Diseased bees need to be cured using methods described in this book. When treatment is over, it is advisable to create physiologically young colony.***

 It’s also interesting that mites that were born on 28th of July lived for 158 days and died before 6th of January; mites that were born on 19th of September lived for 180 days; and the ones born on 29th of September lived 20 days more. Bees survived winter well in all described situations. This was possible because only long-living bees were left for wintering period. Colonies are protected from having brood in the winter time, and thus there are no conditions for nosema development. This disease is usually accompanying brood appearance. Additionally, a beekeeper is enabled to start reproduction according to his schedule, and it is very useful option to have.

This process should not be started too early. The best time to release the queen is when nectar and pollen sources are available, during stable warm weather. This will give the beekeeper healthy and cheap brood.

# Non-contagious diseases

Non-contagious diseases cause much higher bee losses than contagious ones. The reasons for this are several environmental factors that frequently disturb vital activities of bee colonies and have an adverse impact on their body functions. To discover the causes of some illnesses, we should see all the changes and events, take into consideration beekeeping methods, food quality, and availability of nectar and pollen sources.

All non-contagious diseases are caused by poor beekeeping practices, and can be split into 3 groups: nutrition problems, beekeeping technology and selection.

# Nutrition problems

This group of non-contagious disorders occurs as a result of food shortage, or due to presence of toxic matters and mineral salts that poison the bees. Lack of food in the colony, as a result of poor nectar flow, excessive honey extraction, or inadequate food quality, can be deadly to the bees.

# Carbohydrate dystrophy

This is non-contagious disease that can occur when a colony of bees does not get enough carbohydrate food (honey). It can result in mass dying of bees from exhaustion. When there is no honey left in bee stomach, it will die in 10-20 minutes. Such fast death is due to the fact that the bee survives only by using honey, which consists of plain sugars: fructose and glucose. They are digested immediately, without any changes. They are delivered to body tissues for vital functions right away. Lack of reserves in bees’ body determines the need for constant supply of honey.

 The other causes of carbohydrate dystrophy can be crystallization or honey souring due to poor positioning of honey within the hive during the winter. Sometimes bees die after consuming only the honey nearest to cluster, even though there is more of it further out. They cannot consume cold honey on the sides or below cluster. Warm honey is always located above the cluster or in the upper part of the hive.

An average colony can consume about 95-100 kilograms of honey per year. If they were able to collect more honey, it can be harvested by beekeeper. The bees consume approximately 80 kilos of honey during the active brood rearing period, mostly for brood feeding and nectar processing. 20-25 kilos of honey are used in winter and low-activity season.

It often happens that beekeepers are extracting too much honey from the colony. Honey reserves in the beehive can be compared with availability of food in the stomach of warm-blooded animal. Excessive honey harvesting leaves the colony hungry. Honey is then often replaced by sugar syrup, which is not as good for the bees. Honey is preferable to sugar in winter reserves of food.

Sugar syrup consumption in winter time leads to body depletion, and therefore shortening of bees’ life. ***It is very important to avoid feeding sugar syrup to the bees that were born before mid-July. They will enter winter as long-living ones, stay physiologically young and will be able to raise spring brood next year (March-April).***

Sugar syrup processing into winter stocks has to be done by summer generation of bees that will die before wintering starts. A colony that is fed sugar syrup in September-October will have great losses after winter, and can die from varroa even having food reserves available.

**Disease symptoms.** When there is no honey left in a bee’s stomach, it will die in 10-20 minutes. At this time concentration of glucose in its hemolymph declines quickly. Death is a result of body exhaustion and intoxication by protein breakdown by-products. When the bee dies from starvation, it has midgut decay. Sometimes epithelium of midgut disappears completely, leaving only connective tissue.

Having no honey in winter, hungry bees die immediately. In summer they try to find nectar, and die if that is impossible. During a food shortage a colony may leave its hive and join other colony, or abscond to another location in search of a better nectar flow.

During active periods bees may discard larva if there is not enough food. The dead larva can be seen in front of the beehive.

**Diagnosis.** In the winter, a hungry colony makes a sound similar to dry leaves rustling. When there is no noise, one can knock on the beehive and listen again. Silence is evidence of colony collapse.

Examination of a starved dead colony shows that dead bees are located in a cluster similar to live ones. There is no honey near them. However there can be honey around the cluster, usually underneath or on the sides. As mentioned above, bees can’t consume cold honey. Therefore, they can only consume honey in the cluster or above, simply because warm air goes up and heats it. In cold environment bees cannot walk from easily between combs. This can be fixed by making a hole about 12-14mm in the middle of each frame.

Crystallized honey is usually discovered on large areas of uncapped cells. It is dry, compact and thick. Sour honey with alcohol smell is usually a sign of souring or fermentation. One can see streams of honey on the comb. Comb is dirty with excrements and there are often many dead bees on the floor.

**Treatment and prevention.** After spotting the signs of starvation, bee colonies should be fed immediately. This can be done by placing warm (25°- 30°С) comb containing honey close to the cluster. Warm comb can also be placed on top of frames as a ceiling. In this case, one should put pencil-size sticks under the honey comb frame, to allow free movement of bees. A hole of 12-18mm in the middle of the comb will allow them to use honey on the other side of the frame as well. A plywood board or cardboard is placed on top of the frame (also on sticks). The beehive is well insulated again. Sugar syrup (1:2 water : sugar ratio) can be fed as well. It must be warmed up to 30°- 35°С. Punch 3-4 small holes in the lid of a plastic bottle, fill it with syrup and put it in the hive with holes pointing down. Glass jars can be used as well. Tie a piece of cloth around it and turn upside down. Sometimes damp regular granulated sugar is wrapped in gause, and placed on top of the frames.

In spring, a protein paste or honey-sugar dough (300-500grams cakes) can provide extra nutrition. These cakes are also placed on top of the frames. Bee bread or its substitutes should be given to the bees as well. It is important to make sure that the bees are getting appropriate amount of valuable feed. Each colony should get as much honey for winter as many frames it occupies (each no less than three quarters filled with honey).

Colonies infected by varroa mites should receive no more than 5-8 kilos of sugar in August. Acid should not be added to sugar syrup because in our climate (50° of northern latitude) it has a negative effect on bees’ health. If, while preparing colonies for wintering, completely capped comb is used to feed, its lower part should be uncapped. In one day bees will move uncapped honey to the upper part of empty combs. Honey theft by foreign bees and other pests has to be prevented.

# Protein dystrophy

Lack of protein in feed (pollen, bee bread) can cause protein dystrophy and brood death.

**Reason.** Protein dystrophy takes place when there is no bee bread or fresh pollen. Protein metabolism of nurse bees can be damaged greatly; especially if there is a lot of open brood. We should also consider a fact that amount of protein in a bee’s body declines by 20% if they are suffering from varroa mites.

Pollen and bee bread are good sources of not only protein, but minerals and microelements. These products also contain fats that are important for bee nutrition and necessary for both larva and nurse bees. In its lifetime a bee consumes about 100 milligrams of bee bread, and bee colony will eat around 20-25 kilograms of this product.

The nutritional value of pollen from different plant species varies. The best pollen is produced by willow, fruit trees, clover, chestnut, rape, mustard, and radish. Medium value pollen is provided by dandelion, maple, elm, hazel, sunflower. Low nutritional pollen is produced by alder, birch, pine, etc.

Protein dystrophy is especially unhealthy if the colony obtains a lot of carbohydrates. This sometimes occurs when it is forced to process sugar syrup and there is not enough pollen. Protein starvation can also occur even while having enough pollen and bee bread. Certain genetic characteristics can result in disturbed protein or amino acid metabolism. Protein dystrophy is common in some regions where there is a lack of polliniferous plants. This disease usually weakens the colonies and lowers their productivity.

**Disease symptoms.** Protein dystrophy is usually observed in spring-summer period. It is especially harmful when there is a lot of brood. This illness can occur in fall as well when bees are fed plenty of sugar syrup and there is not enough pollen and no bee bread.

Timely supply of pollen is vital when using bees in greenhouses. Less bee bead is needed when the queen is isolated. Protein starvation in larva is characterized by appearance of weak bees that die fast. Protein deficiency also causes the disease resistance of adult bees to decline. They become weaker and die. Thus, we tend to find dead larva and adult bees near the entrance of beehive. Colonies gradually become weaker and perish. Protein dystrophy complicated by nosema or varroa will result in even higher protein consumption.

**Diagnosis.** Protein dystrophy can be noticed by mass death of adult bees of various ages; larva is thrown away from the beehive, and there is a small amount or no bee bread.

**Treatment and prevention.** Bees need to receive enough pollen and bee bread. If needed, these products can be substituted by soybean flour, dry yeast, fresh or dried milk (powder), chicken eggs, and casein. Milk can be used with sugar syrup in a proportion of 0.5 kilogram dry milk to 1.5 kilograms sugar syrup; 300-500 grams of this mixture can be fed to each colony per day. Good results were also obtained by feeding bees syrup including a 10-15% homogenate from drone brood obtained from healthy colonies. However, the best option is feeding bee bread or pollen.

# Honeydew poisoning

Honeydew poisoning is a disease that rarely happens in the summer, but can be common in fall or winter if food reserves contain honeydew.

 Honeydew is a sweet sticky liquid. It can have animal origin or be phytogenous. Animal origin honeydew is produced by aphid, mealybugs, etc. Phytogenous honeydew is accumulated on plants leaves and is not as toxic. Animal origin honeydew appears during daytime in warm weather. Cooler temperatures slow down its producers. This honeydew can contain some microorganisms that increase its toxic qualities.

Honeydew can be poisonous because it contains indigestible carbohydrates (melizitozy, mannose, and lactose esculin), alkaloid, glucoside, saponin, tanning agent, mineral salts and toxins.

**Clinical symptoms.** Initially, forager bees become sick. They die in about 2-3 days. Nurse bees and larva may also become ill. During winter this disease causes diarrhea.

**Symptoms.** The main indication for honeydew poisoning is acute digestion disorder, followed by death. In summer, larva can perish in 3-5 days. Sick bees are unable to fly; they can be observed on the ground with enlarged belly. Colonies suffering from honeydew poisoning exhale an unpleasant odor in winter. While going through such beehive one can see dark brown spots from bees’ defecation on comb, walls, and entrance. Honeydew in comb has no smell, but has an unpleasant metal aftertaste; it is not as sweet as natural honey.

**Diagnosis.** Honeydew poisoning is determined by clinical signs, pathologies of guts and honey analysis. Other disorders with similar symptoms have to be excluded. Honeydew is usually colored dark and has no smell, unlike natural honey. Floral honey is easily dissolved in our mouth and mixed with salvia. Honeydew tastes similar to treacle or cheap caramel; it is not as sweet and difficult to mix with salvia. More precise tests can be done in the lab.

**Prevention.** To prevent collection of honeydew, we should plant nectariferous crops which are blooming in the periods of honeydew appearance. Apiaries can be moved from forest to the prairies, where a nectar flow is not over. When honeydew is spotted in the comb, it should be extracted and replaced by sugar syrup. To prevent mistakes while arranging beehives for wintering, comb with honeydew should be marked and taken away. In summer, full honey comb should be marked as soon as shiny and sticky coating on trees’ leaves is observed. When honeydew collection stops, frames without marks must be extracted. Sugar syrup should be used if there are not enough frames with honey for wintering.

**Treatment.** In summer, colonies are fed 1-1.5 liters of sugar syrup (1:1sugar:water ratio). Colonies that became sick in winter should receive honey or moistened sugar. Early flying is desirable in this case.

# Pollen poisoning

This poisoning is typically observed in young nurse bees that consume pollen from noxious plants. Worker bees bring it into the beehive, but they do not consume toxic pollen themselves and therefore don’t get sick. Poisonous pollen comes from ledum, aconite, honeysuckle, caltha, buckeye, onions, tobacco, cotton, European white hellebore, saffron, eucalyptus, etc. These plants contain poisons such as alkaloids, glucosides, saponins, essences, and others.

During first stages of this disease bees become agitated and exit the beehive. Sick bees fall on the ground, become stiff and die with convulsions. Their guts are overfilled with pollen.

**Diagnosis.** This illness can be diagnosed by considering clinical signs and pathologies. Microscopy of gut contents helps to detect the type of poisonous plant, based on architectonics of pollen granules.

 Pollen poisoning becomes evident by observing agitation at first, and depression later. Initially, young bees die. They have their rectum overloaded with semi-liquid feces.

**Pathogenesis.** 3 to 13 days old bees die between half an hour and five hours after consuming toxic pollen. The clinical progression is faster when there is a lot of brood in the colony because nurse bees consume more pollen and get poisoned fast. Toxic agents slow down intestinal peristalsis. Because of this, guts become overloaded by pollen and bees become poisoned.

**Symptoms and clinical course.** This disorder is typically observed during the month of May, so it is also called “May disease”. Clinical signs are transient. Rarely, it can appear in June, July and even August. At first, there are few sick bees, and then their number goes up. Posioning will stop with the beginning of a nectar flow. For proper diagnostics we should exclude viruses and pesticides poisoning.

**Treatment.** When pollen poisoning is taking long time and there is still no nectar flow, bees should be fed sugar syrup for one or two days (0.5-1 liter per colony, depending on its size and condition). A feeder must be filled with water and placed in the beehive. If nectar and pollen poisoning are detected simultaneously, you should move the apiary to another location with better nectar flow.

**Prevention.** Pollen traps should be installed. Bees need to be given sugar syrup and water while poisonous plants are blooming. The best solution though is to move them to better location.

# Nectar poisoning

This disorder usually affects worker bees. It is caused by nectar produced by toxic plants.

**Causes.** Bees are forced to take nectar from toxic plants when a nectar flow is low. Some plants produce poisonous nectar only in unfavorable conditions. Toxic substances in this case include: alkaloids, glucosides, saponins, essences, etc. Plants producing toxic nectar are: ledum, hog bean, datura, aconite, anemone, delphinium, camellia, buckeye, groundsel, spurge, oleander, ivy, coltsfoot, broom, onions, rhododendron, boxtree, sophora, common yew, tulip, and white hellebore.

**Pathogenesis.** Phytotoxins in nectar are absorbed through intestines to hemolymph. They cause acute poisoning, similar to drunkenness. Sometimes poison acts for a short time and bees recover.

Depending on the amount and chemical composition, poisons have different actions. Bees can die on the poisonous flowers, on their travel back to the hive, or inside the beehive. Most often, the bee’s nervous system is affected; bees lose their ability to fly, start twisting on their back, have diarrhea; wings and limbs become paralyzed. Some plants (such as sunflower, thistle, cornflower, and snakeroot) extract substances that glue together wings, legs, and hairs of insects. This can slow down their movement and cause death. Loss of worker bees weakens the colony.

People can be poisoned by so-called “drunk” honey, collected form rhododendron, ledum, black henbane, hellebore, and datura. The symptoms are drunkenness, general weakness, headache, pain in chest, shiver, pricking in fingers. Patients with these symptoms should be given water containing a suspension of absorbed (activated) carbon, salt laxative, gastric lavage. They should drink plenty of water. Symptoms will go away eventually.

**Symptoms and clinical course.** Toxic nectar is produced in bad weather in June and July (cold rainy weather or droughts). Bees can get sick in this period for approximately two to four weeks. When nectar is very toxic, worker bees die before returning to the beehive. If it is less toxic, they are able to carry it to the colony. In this case many bees and brood perish. Sick bees are active at first, exit the beehive, fall to the ground, gathering together in clusters, unable to fly, and soon die.

Sometimes nectar poisoning can cause queens, drones, brood and even queen larva to die. Poisoning is noticeable within two or three days. Some bees die, and some recover. Whole colonies can die. Sick and dead bees are usually thrown away.

**Diagnosis.** In order to have proper diagnosis, we should consider symptoms, pathologies, and results of lab studies. Analysis for viroses, pollen poisoning, pesticides should be considered. Biological test should be performed as well.

**Treatment and prevention.** A sick colony should receive 0.5 liters of sugar syrup or honey dissolved in water for several days. Feeders are filled with water. Comb with fresh possibly poisonous nectar should be taken away. It is also useful to move bees to a safer location. Planting phacelia, mustard, white clover, sweet clover and other nectariferous plants near apiary can be a good preventive measure. Their blooming should be timed to fill a gap between other nectar sources. Poisonous honey must be decontaminated if fed to the bees.

#  Phyto-poisoning

Phyto-poisoning is bees poisoning by toxins, organic acids, essences, glucosides, alkaloids, and sugars while consuming nectar, pollen or honeydew of some plants. Pollen, nectar and honeydew poisoning are not studied enough. We still have no data on conditions, which result in accumulation of dangerous substances in nectar and pollen (location, soil quality, natural causes, etc).

Phyto-poisoning usually takes place when there are not enough regular nectar and pollen producing plants. These circumstances force the bees to collect nectar and pollen from other blooming plants. Some plants become harmful only in bad natural conditions. They can be dangerous for people as well.

**Diagnosis.** Diagnosis of phyto-poisoning is still underdeveloped. Lab analyses can estimate a source of pollen and nectar from bees’ guts. It is also important to see correlation of sugars (glucose, fructose, galactose, mannose) and alkaloids in bees’ body. This can be done using thin-layer chromatogram or other methods. Biological test can be used as well.

**Differential diagnosis.** Phyto-poisoning usually has a longer clinical course than viroses, spiroplasmosis, and pesticide poisoning. In every case, when bees could be poisoned by phytogenous toxins, we need to examine honey in accordance with veterinary-sanitary expertise methods for beekeeping products.

#  Alimentary diarrhea

Also known as non-contagious diarrhea or dysentery, alimentary diarrhea is dyspepsia from consuming poor quality food.

**Causes:** Feeding impure sugar syrup (unrefined or burned sugar, remainders of confectionery, fruit or vegetable juices), winter stocks with incompletely inverted sugar (when feeding takes place in late fall), addition of acids to sugar syrup, souring of honey, and other contaminants in food. Digestion disorder can take place due to increased food consumption. This occurs if bees feel anxious when there is no queen, or she is laying eggs too early in the spring, a long wintering period, poor ventilation and insulation of the beehive, and high humidity. Bees get diarrhea when their intestines are filled by 33-45%. This disorder can cause weakening of bee colony in fall and beginning of winter.

**Symptoms and clinical course.** Alimentary diarrhea is most typically observed in winter, but can occur in summer after long period of cool, rainy, weather. In autumn it may happen if bees collect and consume juice from overripe fruits and vegetables. Sick bees have a bigger abdomen; they appear very anxious, defecate in the beehive, leave the cluster, fall on beehive’s floor, leave the hive and die. The beehive is filled with unpleasant smell, spots of faeces can be found on comb. Bees usually start to recover after flying on cleansing flights. Complications can appear in the form of nosema, salmonellosis, colibacteriosis, hafniosis, honeydew poisoning, etc.

**Treatment and prevention.** One of the most important preventive actions is to enable bees to fly early in the spring season. Bees can be encouraged to fly after eating warm sugar syrup (about 35°С). Food stock is replaced by high quality sugar syrup. Spare comb should be removed. Make sure the bees are well insulated and warm. Dead bees should be gathered and burned. The colony can be moved to a clean beehive. Old comb is melted down and processed. Beehives need to be disinfected (same way as for foulbrood).

High quality food and good living conditions are the best preventive measures in this situation. The best time for feeding sugar is July (January in Southern hemisphere). Clean drinking water should be used to prepare syrup. Each colony should receive no more than 5-8 kilos of sugar.

# Anomaly in bees’ body

Anomalies in bees’ body can be diverse but happen rarely. In some cases appearance of abnormal bees does not slow down a colony much. However, we need to remember that disorders that lead to slight anomalies can be related to deep changes in bees’ body, which can stay and become hereditary. Deformities in bees can be conditioned by cytological abnormalities, mutations or unfavorable life conditions. We know about 30 phenotypical mutations of honey bee. Twenty of them are related to eyes’ color, three are related to eye structure, five result in wings deformations, and two are variations in body and hair color.

 Eye’s color of mutants varies from white to brown (including yellow, orange and red tones). It is a result of pigment synthesis in bee’s organism. Each mutant has certain eye color, which becomes hereditary. Change of eye color most often occurs in drones. The ones with dark red-brown eyes have enough strength for good flight during mating. Drones with white eyes have weak sight and cannot mate. When a white-eyed queen mates with a white-eyed drone, approximately half the queen’s progency of drones and worker bees have anomalous compound eyes. These bees also have a reduced upper part of their wing nerve. Queens with greenish-yellow eyes fail to return to the beehive after mating approximately 25% of the time (Gaud-Netto, Stort, 1980).

Eye color depends on the presence of pigments (ommochromes) that perform as a screen for the eyes. Deficiency of these pigments can be explained by extreme activity of tryptophan oxygenase, which causes tryptophan and serotonin accumulation in hemolymph of bees. They hinder ommochromes accumulation. Without sunshade, pigments bees’ sight deteriorates fast. Accumulation of the above-mentioned amino acids in hemolimph reduces excitability of the nervous system. Therefore, the number of dancing bees goes down; the rhythm of the dance becomes slower, and ability of bees to mobilize for nectar collection is decreasing too.

Mutations related to eye structure include absence of eyes (anophthalmia), absence of ocellus (ommatidium), reduction (fewer ommatidiums on eye), cyclopia. Some bees have one compound eye on top of the head. The first two mentioned distortions are typical for drones, while third one was noted in worker bees as well. Insects with reduced ocellus usually have red or brown eyes. Number of ocelluses can differ in one or both eyes. Genes responsible for white eyes are hereditary.

Frequently bees get undeveloped, crushed, or no wings at all. These defects are noted in all types of bees, but most commonly in drones. Such crippled bees rarely appear in healthy colonies. These defects are more frequent when bees are suffering from varroa mites, which is important to remember for proper diagnosis. Queens with crushed wings usually develop in queen cells on the periphery of brood in cold weather. Wing deformations are possibly induced by subnormal temperature of brood in pupa stage (Fig, 1959; Jey, 1963; Takker. 1978). Hereditary factors are also important.

Some colonies have bees, queens and drones with distorted antennas, mouths, or legs. These anomalies are considered hereditary; they stay for tree generations of bees. Causes for such distortions are unknown. Sometimes they appear if brood has been chilled (Kenniger, 1978). Sometimes young bees have no rear legs. They can’t stay on the comb. Such bees do have rudiments in a shape of small hooks, but still cannot walk properly on comb and fall on beehive floor. To prevent this distortion, a beekeeper was planning to replace a queen, but it stopped without assistance. Obviously, sperm and ovule had the same allele, bearing signs of legs absence. When this sperm was used up, normal bees were born.

Queens sometimes get stunted ovarian tubes, hypoplasia (underdevelopment) of an ovary, excess ovarian tubes, accessory ovarian follicle, ovary skewness, doubling of ovary, or a membrane between an ovary and oviduct. It may also happen that one or both oviducts are absent, a spermatheca is underdeveloped or duplicated, a venom gland is manifold, reservoirs of small and large venom glands are dislocated, or guts are skewed. Some of these deformities are hereditary.

Considering mentioned above anatomic-histological changes, it becomes clear why some queens cannot become prolific. For instance, presence of membrane between ovary and oviduct will stop movement of eggs, which will make queen infertile. She might have poor fertility if only one ovary is functioning. Thus, even healthy looking queen might be unfit for reproduction. This is also true when she has one or no oviducts.

With undeveloped or no spermatheca a queen will not be able to receive sperm and will become drone-layer.

Other deformities in queens’ body will result in its low productivity.

In all these situations we will be motivated to change the queen, even though the reason for its poor performance is unclear.

Anomalies in drones’ development are less studied. Drones with geminated testicles or without testicles have been discovered. In cases of inbreeding, inbred drones have lower longevity and become more sensitive to low temperatures. Their first flight is delayed, the number and duration of flights is shorter, and the number of sperm cells goes down. Additionally, sometimes such drones have digestion problems. Varroa mites are often responsible for pathologies in drones. At first, they simply parasitize. Later, the mites can cause change in wings’ shape, making drones unable to fly. Mites can also lead to pathologies in testicles and cause a drone’s inability to mate with a queen.

 Mutations of bees’ color, for example from black to tawny, which is called “kordavan”, is widely used in studies of heredity. It is still unknown if changes in coloring are related to any negative changes in colony development. This type of mutation is common for apiaries in Europe, North and South America.

Hairless bees (black disease) are born with black body that is not covered with hairs. These bees are usually not viable and are rejected from the beehive by healthy bees. Sometimes mature hairless bees die in comb cells. This is a hereditary disorder. However, we should be able to differentiate hairless bees, which appear due to chronic viral paralyses.

 **Gynandromorph** (hermaphrodite) – are bees that have parts of their bodies typical for male and female individuals. Location of these organs can be diverse: some bees have worker bee head and thorax and abdomin of a drone, or the front part of the body is drone-like and rear similar to one a queen would have. One bee can have haploid and diploid drone tissue in the same time.

**Causes** of gynandromorphy are diverse. It happens frequently when tissues of female zygote develop together with one or several sperm cells of gynandromorph. Rarely do we see simultaneous development of zygote and maternal drone tissue. However, we do not know if an egg is fertilized after fission, or insemination of double-nucleus egg takes place. Gynandromorphy is hereditary. It is rare for colonies of bees, but can appear in cases of inbreeding when up to 40% of bees can have these features. Sometimes gynandromorphy is caused by external causes, such as cooling or overheating of eggs during the 20-30 minutes after the egg is laid. In these cases queen has to be replaced to correct the problem.

Young queens might have not enough sperm in spermatheca if they emerged in a period of unfavorable weather in late summer or autumn with few drones available for mating. They start to lay unfertilized eggs after approximately 3-5 weeks. Spermatheca in this case is filled with a transparent liquid. Unfertilized eggs can be laid by old queens (4-5 years old) as well that have experienced a natural decline of oviposition. These queens usually have degeneration of venom gland wall. It turns brown or black and stops producing venom. Malpighian vessels of the queen change color from clear to yellow, greenish-yellow, and dark green by third year of its life. One year old queens have yellow oenocytes of body fat, which turn brown later. Four-five years old queens are have less sperm in spermatheca, and start laying more unfertilized eggs. Normally queens mate with 6-10 drones. Each drone has about 0.85-5.20 milligrams of ejaculate, which contains 5.3-7.9 thousands of sperm cells (Voike, 1973; Taranov, 1968). Queens sometime lay small numbers of unfertilized eggs in worker cells. They can be located on the wall or edges of the cell.

 **Temporary drone laying queen.** Young mated queens can lay drone (haploid) eggs for some time. In this case we’ll see thelytoky (drone) brood. Later it will normalize. There are cases when a prolific queen lays unfertilized eggs in its colony and diploid (fertilized) in another’s. Reasons for such behavior are unclear.

 **Abnormality in eggs laying.** Prolific queens may lay several eggs in one cell. This can take place when there is a shortage of comb in the colony during active pollen collection, or an insufficient number of nurse bees and no prepared cells on the comb. In this situation eggs can appear on the floor of the beehive (usually they are drone haploid). Sometimes eggs can be discovered on the wall of the cell.

**Sterile queens.** Queens may become sterile due to disease, which causes are not known. Mature and young queens sometimes have fast decaying ovarian tubes (ovary atrophy). Empty ovaries stop functioning. Products of tissue breakdown are absorbed by the body, making fat tissue grow, and the amount of hemolymph is increased, causing a swollen abdomen. Changes in midgut are also visible.

Some normally mated queens become “drone layers”. For their age, they have a non-typical mass of amyloid in the spermatheca wall. This organ may get amyloid degeneration of epithelium, which causes sperm to die.

In some cases we can see degeneration of spermatheca and a gland “serving” this organ. Secretion abnormality can be a reason for inability to fertilize uterus.

**Tumors.** Cases of venom gland tumors have been registered in prolific and year old virgin queens. Berman discovered multilobate growth between spermatheca and vagina. When spermatheca and gland get squeezed, sperm cannot travel and queen starts laying unfertilized (haploid) eggs as a drone-laying queen. Ershi-Pal (1937) described tumors in small intestines of the bees.

Bunches of gigantic cells were discovered in 18% of bees’ bodies after they passed the winter with regular epithelium cells. At first, vacuole appeared around cell nucleus. Its amount increased gradually. Cells’ limits disappeared and gigantic cells were creating one tumor body with protoplasm remains. Tumor body was lying in basal membrane. Cell nucleuses were left without changes at the foundation, sometimes had irregular or triangular shape, and were easy to color for microscope analyses. Small intestine was enlarged, and intestine walls exfoliated near the tumor.

**Uterine tubes blockage.** This disorder usually causes infertility of queen. Some queens do not lay eggs after mating because their oviduct is plugged by sperm. In this case queens’ abdomen becomes enlarged and the oviduct appears swollen when dissected. The spermatheca is filled with normal sperm, but it thickens in oviduct because of mucus with “circular sperm” (tail of sperm is twisted around its head). One of the reasons for these plugs may be large quantity of secretion of drone’s mucous gland, which gets into ejaculate after penis and associated abdominal tissues are ripped from the drone's body during sexual intercourse.

A drone’s genital organ often closes the queen’s vagina. It can be carefully removed by tweezers if sexual intercourse took place within the past one or two days.

Uterine tubes blockage can also occur when they are squeezed by internal organs. Young mated queens that are unable to lay eggs sometimes have hard orange masses in large intestine and malpighian vessels. These masses are squeezing the uterine tubes and queen is unable to lay eggs. Reasons for the development of such stones are unknown.

Intestine obstruction may appear as a result of connective tissue enlargement. Warts and blisters, colored golden yellow or dark brown, which contain rod-like bacteria, can appear for unknown reasons. Apparently, bacterial ulcer of epithelium is one of the stages of the same disease.

Queens can become unable to lay eggs also due to intestinal weakness and constipation, when fecal lump closes the anus and vagina entrance (same for melanoma). The fecal lump can be extracted, and queen will continue to lay eggs if intestines recover to work normally. Some sources also describe cases where virgin queens laying haploid (drone) eggs also had damaged intestines.

**Queens’ catalepsy** (epilepsy, shock). Sometimes after being caught by the wings, a queen may bend its abdomen, stretching its top to the head, and it becomes stiff immediately. This state can last from several minutes to one hour, which causes queen to die. Usually catalepsy is noted in young bees with a large, well developed abdomen. (Brohert, 1974, Taker, 1978).

# Hereditary diseases and abnormalities in bee’s embryonic development

Hereditary diseases are pathologies in colonies of bees or individuals that are caused by genes recombination, changes in chromosomes or embryonic development.

Reasons for these disorders vary. In some cases they are conditioned by physical, chemical and biological factors of the environment. These factors influence genetics of gamete cells, which is fixed by breeding (especially by inbreeding). This can be used to the beekeeper’s advantage to increase production of beekeeping products, but can lower bees’ endurance. Worth health characteristics can be enhanced and passed on from one generation to another through chromosome and genetic changes in body’s cells.

**Diagnosis.** Anamnestic data should initially be considered. Gather information on apiary isolation, beekeeping practices, delivery of queens and drones from other apiaries, etc. Infectious and invasive diseases should be taken into account as well.

**Treatment methods.** Queen replacement is normally the first action against all diseases that are caused by chromosome changes. Disorders in embryonic development can be stopped by improving the quality of feed, elimination of extreme temperature shifts and other physical and chemical factors.

**Sterile eggs.** These eggs look normal, but do not develop or stop growing at a certain stage.

Reasons for appearance of such eggs are unknown. Possibly, they can result from triploidy, a chromosome abnormality. In this case the queen lays partially or completely nonviable eggs, depending on the level of genetic abnormality. Sometimes sterile eggs appear after a certain period of normal queen functioning. Maul (1977) surveyed changes in the embryonic development of eggs that were laid by artificially inseminated queens (sperm came from Indian bee drones). Colonies with such queens are weak; eggs in drone and worker cells are leaning toward the bottom of the cell and have an uneven growth pace. Eggshells are often wrinkled. Sometimes the queen lays more than one egg in a cell.

**Black eggs** (Arnkart disease). Mature eggs become swollen and ball-shaped. Their content is degenerated and has yellow-brown or black color. Arnkart believes that the eggs die from chilling. Other scientists have found fungi in such eggs. Treatment and prophylactics against this disorder have not yet been developed.

# Anomalies in eggs laying

Some queens tend to lay a scattered brood nest. In this case we see patches of brood, where it appears the queen “missed” some cells. Sometimes this occurs when drone brood is developing in worker cells. This is also possibly due to either: the queen mated with drone that has dead sperm; queen is virgin; queen has no sperm left, or the sperm died due to cooling during its shipment to another location. Sometimes eggs are located at the edge or on the side of the cell, which are usually cleaned up by the worker bees. Larva can also die after being capped. They turn grey or black color, and form a sac with a liquid content. Such larva dies due to various reasons. Some queens are unable to produce drones in their offspring.

**Diagnosis.** Other disorders causing scattered brood need to be considered (sterile eggs, diploid drones, and genetic lethality). Some abnormal brood may be cleaned up by worker bees following an infectious disease.

# Diploid drones

Diploid drones are organisms which carry two sets of chromosomes (diploid-homozygous). They do not survive in the colony because worker bees eat these larvae within 6 hours after hatching. Chemical composition of these larvae is different from normal homozygous-haploid drone larvae (Voike, 1962, 1963. 1967). It is possible to obtain sexually mature diploid drones in the lab. They usually produce diploid sperm (Voike, Skvornek 1974). Diploid drones become sexually mature in 12-37 days, later than the normal drones (8-10 days). They have undeveloped testicles that produce small amounts of sperm. Each spermatozoon is twice the size of normal spermatozoa. Only 24-30% of diploid drones are suitable for reproduction (Gaud-Netto, 1973, 1977, 1979; Voike, 1983).

Diploid drones will appear in offspring of queens mated with drones that have similar sexual allele (alternative forms of a gene). Their number can reach 11 or 12 (Mackesen, 1955; Laidlaw and others, 1956). These queens can produce the same amount of heterozygous and homozygous eggs. Worker bees and queens develop from heterozygous eggs, while diploid drones develop from homozygous eggs.

The above pathologies are more common when queens are mated with drones born by their sister-queens. Approximately 75% of such queens will produce diploid drones (Voike, 1972, 1980).

Colonies with such queens develop poorly and never become strong. They usually have scattered brood. Up to 50% of brood can die depending on the amount of undesirable sperm in queen’s spermatheca. On the average, 24% of brood is lost due to long term inbreeding, with a range of 2-47% (Shaskolsky, 1968; Voike, 1976).

# Genetic mortality

 Genetic mortality (non-contagious genetically scattered brood, empty brood cells) is a disorder of bee colony that is characterized by scattered brood due to death of larvae, prepupa, and pupa that have lethal genes. This pathology often results from long term inbreeding. Losses from genetic mortality vary from one generation to another, and can reach up to 18% of worker bees and drones (Mackesen, 1958). Genetically-caused mortality is hard to observe. Typically, the colony develops poorly and brood is scattered. Capped brood in prepupa stage is affected most often. It turns grey or black, has a sac form with a liquid content that often looks like sacbrood. Pupa and emerging adults die, unable to open the cap (Fig, 1959; Tukker, 1978). Infectious diseases have to be excluded for proper diagnoses.

**Prevention.** Do not allow inbreeding.

# Parthenogenetic female bees

 This phenomenon occurs when a female bee develops from an unfertilized egg. These bees usually serve as workers, but can become queens as well (Mackesen, 1943). A recently laid unfertilized egg can develop a double nucleus under the action of abnormally low or high temperatures. Later, female bees will hatch from such unfertilized eggs (Tryasko, 1975).

Parthenogenetic female bees look like normal worker bees, but rarely appear in colonies. They can be found as offspring of a laying worker or virgin queen.

# Pupa deformity

Several kinds of honey bee pupa abnormalities are described in literature. Fig (1959) was examining white-headed bees (not white-eyed). Head is white, not pigmented. Other body parts have regular pigment. Most likely, pupa dies due to the lack of oxygen, when prothoracic stigma is blocked. Another anomaly is characterized by greatly reduced abdomen of pupa, while head and thorax are oversized. Digestive apparatus are moved to thorax. Laidlaw and Eckert (1962) reported humped pupa with large thorax and compressed head. In some cases, nonviable queens can emerge with small heads (microcephaly).

Honeybee pupa can also exhibit a premature hardening of their exoskeleton, or lack of exoskeleton on queen’s pupa abdomen. Growth of two pupas in one queen cell is considered abnormal as well.

**Treatment** for these anomalies has not been developed yet.

# Long queen cells

When drone (haploid) larva is growing in queen cell, bees build a long, thick, queen cell, but will be unable to cap it. Drone larva does not consume royal jelly well. At the age of 3-4 days, the larva requires a mixture of bee bread, pollen and water. The drone larva in a queen cell fails to consume much royal jelly and instead floats on top. The long queen cell will be filled with royal jelly.

In 1978 Voyke and Bobrchetsky have described a contagious disease they termed “long queen cell”. It is usually observed during the end of spring or beginning of summer and is characterized by an elongated narrowing at the end of queen cells. They can grow to 23-60 millimeters long (on the average 32.6mm), while the normal length is 23-30.5mm (on the average 26.5mm). Larvae in such cells are elongated as well. Their mass is low, they do not cocoon well, and walls are thinner than usual. Larvae die in prepupa stage, with clinical signs similar to chalkbrood, sacbrood or European foulbrood. Infection spreads through royal jelly while grafting, or when using same queen cups repeatedly.

# Abnormally small body size

Sometimes we see smaller than usual but proportional worker bees, drones, and queens. An average bee is 12-14millimeters long, weighs about 100 milligrams; drones are 15-17mm long and 200mg in weight; queens are 20-25mm long and weigh 185-190mg (virgin) or 200-210mg (mated). Bees’ growth inhibition and weight decline occurs in situation of food shortage.

**Reasons** for insufficient nutrition can be one of several: lack of natural nectar, not enough nurse bees in a colony, old nurse bees, number of pathologies caused by diseases (nosema, varroa). Another reason for appearance of small worker bees can be their development in old comb with smaller cells. Small drones sometimes emerge from worker cells. Queen cells may be small when colony has too many queen larvae to feed. The number of queen larvae should not exceed 24 every 3-5 days in a normal queen-cell builder colony. Nanous bees in a colony can be a hereditary event as well.

Smaller size and weight of worker bees leads to decreased honey production. Smaller queens lay fewer eggs, slowing down colony growth. Smaller, underdeveloped drones are not always able to mate.

**Preventive measures.** Bees must be provided with sufficient, high quality nutrition to develop well. Old black and dark-brown comb should be removed from a hive, because they have smaller cells, covered with cocoons which were left by emerged bees. Queen rearing colonies should not be overloaded by too many queen cells. Queen cells that are too small should be destroyed.

# Laying worker bees (thelytoky)

Mandibular pheromone, emitted by a laying queen, is one of the most important pheromones in the bee hive. It makes a bee colony a super-organism and inhibits ovary development in worker bees. Some worker bees start to develop ovaries when their queen dies, ages, or is out of reach (for example caged). If they cannot lick queen mandibular pheromone off her body (and there are also no eggs or 1-3 days old larvae), worker bees start laying unfertilized (haploid) eggs that become drones. European bees usually start having laying workers 23-30 days following queen absence; bees in Middle East – in 16 days; African – in 5-10 days (Ruttner, Hase, 1981). However, appearance of laying workers also depends on the condition of the colony. Some European bees will develop laying workers two weeks after queen and brood absence. Some worker bees start laying eggs right before brood hatches out. Sometimes colonies with no brood and an absent queen do not develop laying workers (Tacker, 1978). Worker bees become laying workers after consuming food meant for queen larva (royal jelly). As a result, their ovaries become more active and start producing eggs (Poltev, 1964). Usually, there are several laying workers at the same time (15 and more in African bee colonies). They have characteristics similar to queens and therefore may be called “fake queens”

Bees start actively cleaning cells shortly before laying workers appear. Brood presence makes them even more active. Workers lay eggs in a scattered manner, using cleaned and non-cleaned cells, sometimes with residue of honey or bee bread in them. They attach eggs to the side of the cell, sometimes laying several eggs in one cell. Each laying worker can produce from 19 to 32 eggs. In colonies with a failing queen and several laying workers, the laying workers lay eggs in a separate area or between drone and workers brood (Koptev, 1954, Tacker, 1978).

When workers are laying eggs in worker cells, sealed drone brood will have dome-shaped cappings (“bumpy brood”). Sometimes the workers in a queenless colony may even start a queen cell with drone larva in it. Such queen cells become too long, since drone larva, being 3 days old, requires honey, bee bread and water mixture instead of royal jelly. Naturally, colonies with laying workers are weak, often with lots of drones. Drone brood is scattered, there is no worker brood (a small area of workers brood when failing queen is present). Such colonies have no food stocks, because they are consumed by laying worker bees. Thus, without immediate help these colonies will die.

The main signs of laying workers presence are lack of worker brood and scattered bumpy drone brood. Usually it is located in the middle of the comb. These colonies are reluctant to accept a new queen. It is usually easier to introduce a new queen in spring rather than in August-September.

**Treatment.** The laying worker colony should be placed in cool room; all brood should be taken away. Frames with uncapped brood and eggs form healthy colonies should be placed in the colony. Amount of new brood should meet colony’s ability to feed and warm it up. In 6-7 weeks (after being capped) the brood is returned to the original colony. After that, treated colony gets lots of open brood and eggs from strong colonies. In 6-8 days emergency queen cells have to be destroyed. Part of the capped brood stays in the colony, and a new mated queen is introduced.

Shaking the bees off the frames away from beehive is not effective for getting rid of laying workers, because there are several of them and they can fly. Colonies can be cured after receiving caged queen from another colony. Beehives must be moved to support relocation. Donor colonies should receive a queen from another colony or nucleus. Sometimes, application of an artificial mandibular pheromone has a positive effect, and slows down ovary development in worker bees. When it is impossible to cure the colony, it should be liquidated by taking apart the beehive, installing the frames in other colonies and letting the bees scatter in the apiary.

For prevention, it is important to ensure that every colony has a queen. It is useful to have some extra queens at the apiary in nucleus colonies.

# PAST, PRESENT, AND FUTURE

# OF BEEKEEPING

Most beekeepers will agree that it is desirable to improve modern beekeeping practices. The main threats are diseases and pests that weaken or kill bee colonies and thus reduce beekeeping productivity. Occasionally, beekeepers with failing bee colonies become discouraged when working with best creature on earth – the honey bee. This should not happen. We should remember the past, analyze the present and look into the future.

It is essential that we first recall that bees have natural protection mechanisms. Wild bees lived without human help for centuries. Their life actually became worse after meeting humans. People are primarily concerned with obtaining profits. Well being of bees is important only for productivity. This attitude causes all the problems in beekeeping.

All activities of feral bees were useful for their colony. Their location in tree hollow was perfect. Rotting wood is a great heat-insulator. Covered with fresh wood and bark, it created perfect environment for life of bee colony. Bees would build their nest at the ceiling of such hollow, as the warmest and cleanest place. Spacing between nest and the floor became a sanitary zone. All the debris cleaned from the comb or other parts of the nest would fall on the floor, thus isolated from colony activities. This lifestyle was good for natural prevention and treatment of brood diseases. Also, since colonies of bees were scattered across a large territory, infectious diseases had difficulty spreading. A more or less even distribution of bees’ over an area created good conditions for nectar harvesting. Infectious diseases were pretty rare at that time. Additionally, bees would change location only due to swarming. Nowadays they are moved by planes, trains and trucks. Such mobility promotes spreading of disease.

 Let’s analyze the transmission of infections by drones. First of all, drones die after mating with a queen, which prevents them from carrying infections back to the beehive. Further, weak colonies do not raise drones. Thus, when colony is weakened by some pathogen, there are no drones to transmit it to other colonies. These mechanisms are very important for bees well being. Wild bees also lived in tree hollows high above the ground, allowing them to have better hygro-regime (stable humidity).

We can conclude from the above that colonies of bees were protected from diseases by biological characteristics, including behavior patterns. Thus, majority of colonies obtained by people were healthy. Most illnesses in bee colonies were promoted by beekeeping practices.

People started keeping bees. At first, they would provide the bees with an artificial hollow in a tree trunk. These locations were reasonably comfortable for the bees. Later, beekeepers created gums and log houses. They were placed on the ground where humidity is higher. Therefore, colonies were placed in worse hygienic conditions. The main drawback of beekeeping in log houses is inefficient honey harvesting. To obtain honey, the bee colony was usually killed by smoking. Ironically, it was usually the strong colonies with more honey that were killed. Less productive colonies that were light with honey would be kept another season. Thus, the beekeeper effectively selected less productive bees to continue breeding. Log houses had an advantage over modern hives, though: Wax comb construction in them was created by bees and better-suited their needs in winter time than comb created on uniform man-made comb foundation.

Construction of such natural wax comb enables bees to walk from the center to the periphery and back in any direction. Therefore, in winter, bees have access to all stored honey. However, log hives are not convenient for a beekeeper. Honey gathering requires killing the colony. Due to this and other shortcomings, beekeepers eventually switched to using beehives with frames, invented by Prokopovich. This was a revolution in beekeeping, allowing honey to be harvested without destruction of the colony, but new technology had its drawbacks: it did not adequately take into consideration some biological peculiarities of bees. First of all, there is no significant space between frames and beehive floor. Thus, debris containing disease spores, bacteria and even parasites on the floor may stick to a bee’s body and be returned to the nest. This promotes development of diseases, especially brood diseases. The increased number of observed disorders motivated searches for medications against them. Antibiotics proved to be especially effective. Their use for prevention was, and sometimes still is, frequently used and considered acceptable. However, according to studies of Likhotin (1989), hemocyte (an element of hemolymph) becomes squeezed under the influence of antibiotics. They become unsuitable for phagocytosis (destruction of causative organisms). Additionally, antibiotics cause disbacteriosis, killing beneficial microorganisms in bee’s digestion system. Mass use of antibiotics lowered general body resistance of the bees to bacterial disease. Application of organic acids had a similar effect.

Bees became more susceptible to infections, which has been especially evident with chalkbrood. In this case we see a paradox, when one of the oldest earth inhabitants (saprophyte) becomes causative agent of a disease. That is important to understand, because it is highly resistant and well adjusted to the environment. This means that chalkbrood cannot be immediately solved, and bees have no way to get rid of it. Chalkbrood (Ascosphaera apis) can’t be destroyed, but it is possible to relieve the stress it causes. Prevention is important in this case: bees should have no contact with waste on the beehive floor, selection should be aimed at obtaining more resistant bees, and beehives should be well insulated. The optimal temperature for ascosphaera apis development is 30°С, but bee brood growth is best at 35°С. This temperature and no less should be kept in the brood nest by providing good insulation. We should focus more on the temperature regulation for other reasons too. Appropriate temperature conditions, supported by good nutrition, will help to prevent other diseases. Temperature balance can be checked by thermometer or through observing the hive entrance. When we see bees fanning the hive, the temperature in the nest is sufficient. It is important to have such temperature in coolest part of the day (morning).

Future technologies of beekeeping should meet certain requirements: no more than 60 colonies should normally be kept in one location. Meeting this requirement will lower the number of sick colonies in case of infectious disease.

Special attention should be paid to beehive design. It is desirable for it to meet following requirements:

а) Bees should not have contact with beehive floor;

b) Temperatures in the hive must be suitable for brood development.

Future changes are likely to be made in the design of modern movable frame beehives. If new beehives will meet requirements mentioned above, beekeeping will succeed greatly. The author believes that movable (Langstroth) hives will be more convenient for these reasons. Apiaries of the future have to be mobile to be able to utilize nectar and pollen sources in different locations.

Wax foundation has to be produced from decontaminated wax, to stop infections from spreading.

Beekeeping products should be sold well-packed in different volumes, and have no contamination with medications.

Beehives and beekeeping tools need to be produced in well-equipped workshops, meeting all design requirements.

Farmers, growing crops that benefit from insect pollination should pay for it. Usually, pollination services cost almost 20 times more than honey. For example, pollination in the USA averages about $50 USD per hive delivered to the crop, except for almond pollination where beekeepers receive over $100 per hive.

In developed countries, such farmers are ready to pay for pollination and even sometimes provide timely transportation for the bees.

The main selection criteria for bees should be their resistance to diseases. We should never forget that bees previously had good natural immunity to infections and invasions. Catastrophic immunity decline is a result of human behavior and modern beekeeping technology. Therefore, changes in technology should be supported by selection work, enhancing bees’ immune mechanisms.

New technology must be expanded to combine favorable factors of wild bees’ lifestyle with positive sides of existing technology.

The period with brood should be minimized, and broodless period extended. **Extra brood results in decreased productivity of bee colony.**

Medication against contagious diseases should not be used in the future. All wax must be decontaminated using Khmara and Bondarchuk method.

Author recommends using movable frame beehives (Langstroth, Roje-Delon, etc.)

It is desirable to develop one-meter-high supports under brood boxes to create ethological immunity.

Queen cages must be large, made in accordance with new technology, developed by the author (Petro Khmara). Cut in sections, a cage loses its veracity, especially during wintering period. Size and shape of the Khmara cage allows optimal temperature control for the queen. In a smaller cage, the queen may be left outside the winter cluster as it moves within the hive.

# Progressive economic beekeeping technology

(Remarks about modern technology)

 Peculiarities of bees’ reproduction are not generally taken into consideration by modern beekeeping on Earth. Beekeepers do not know much about potential longevity of honey bees. Biological life of bees has been shown to achieve 396 days or 13 months, which is more than a year (Mauricio, 1958). This book contains information on beekeeping methods that are based on life expectancy. This achievement must become well-known and included for the technology of beekeeping to advance further. The following description is aimed to enable all beekeepers to benefit from creative application of these new methods.

# Technology based on reproduction regulation

The best time to start a new colony life cycle is the period after the main nectar flow or after a secondary one if it is big enough. Queen should not be isolated at the period, when minor nectar flow is expected. Foraging work does not affect bees’ longevity much, so minornectar flow is a good way to preserve colony strength and health. Availability of pollen and bee bread is compulsory. The best period for isolating the queen to improve overall colony strength is July, no later than second week (for Kiev region, 50° of northern latitude). Queen isolation should be earlier for the territories in the north and later in the south. The best timing indicator in this case is a period with maximum amount of brood. So-called autumn build-up of colonies is rarely possible. Colonies should not be encouraged to expand in August-September, and especially not in October. Increasing the number of bees in the colony during this time actually makes it weaker. Important factors are: shorter daylight periods, cooler weather, rains, lack of nectar and pollen, etc. Some literature on beekeeping suggests that broodless periods should be as short as possible. Some experts believe that it is useful to have brood even during the winter time. These hopes and beliefs are mistaken. The fact is that raising brood during the inactive winter period is difficult and even harmful for a colony because it has to produce royal jelly, use organic food stocks and generate more heat to maintain a proper brood nest temperature. All this work stimulates bees to consume more food and overfill their guts. Therefore, absence of brood during inactive periods is vital for saving potential strength of the colony. Importantly, each bee that did not need to feed brood with royal jelly can live much longer. The less royal jelly produced by a worker bee, the longer it will be able to live (up to 13 months).

Every beekeeper or scientist can easily verify this concept. To do so, split colonies in two groups of similar strength, good productive queens, similar resources and environmental conditions. Sufficient honey reserves should be provided for winter. In the appropriate season as described above, isolate queens in the experimental group. Record the date and weigh colonies if possible. In 21 days the youngest bees will hatch. In August, control colonies will be storing honey for winter time as the last bees emerge. The volume of food consumption should be recorded as well. Later, all colonies will require pollen and bee bread. Most territories have sufficient pollen sources in fall. The date for the last fall emerging bees in control colony is noted. At this period it is reasonable to compare the strength of control and experimental colonies. During a winter warming period, colonies should be checked for brood presence by looking at frames in the center of the cluster. At the end of winter, the amount of brood and its probable age should be recorded. Queens in the experimental colonies should be released from cages when first pollen-producing plans begin to bloom. Colony strength and first flight date are registered as well. At this time you can check the volume of dead bees in both groups. During the course of winter mite death counts may also be recorded, including their complete extinction in experimental colonies. In 20 to 30 days following, the amount of brood, colony strength, and other metrics in both groups of colonies should be recorded and compared. Productivity of bees should be compared depending on the production aims. Use as many performance metrics as possible. Compare results with other beekeepers if possible for a better understanding of this new method.

If there is only one early nectar flow and nectar sources will become scarce later, reproduction should stop shortly after the end of nectar flow, preparing colonies for winter in June-July. In this case, it might be practical to feed colonies, helping them to reach maximum strength before reproduction is stopped. Later, a secondary nectar flow will not affect power of the colony; it will be strong enough to survive winter. Bees in these colonies are physiologically young and can live more than a year. Their ability to feed brood will remain for 12 months too. Brood that remains in the colony after queen is being isolated will turn into these long-living bees. Sometimes, stressful living conditions in winter can lower their life expectancy. Thus, hives should be protected from mice, well insulated, ventilated, protected from wind and other environmental adversities. Only high quality food should be used in this period.

In some areas, summer provides two or more nectar flows with a long interval between them. If there is enough brood, it might be a good idea to stop reproduction to prevent the rearing of an extra generation of bee that must be fed and will thus lower longevity of the existing worker bees. Approximately 9 or 10 days before a strong nectar flow you should isolate the queen, thus enabling the bees to concentrate on honey production.

Similarly, when bees are in an area with acacia and buckwheat nectar flows, queens should be isolated 10 days before acacia bloom. In Kiev region, this queen isolation will take place approximately from 1st till 10th of June (June 20th if you are located in flat land; and between the 25th and 30th of June in mountainous regions). During this period, it is best to extract honey and release queens the next day. Approximately 6 or 8 kilograms of honey should be left in each colony, depending on colony size.

Bees can be moved to buckwheat when the acacia bloom ends. Between these main nectar flows, there might be linden blooming or some other nectar sources. Queens should be isolated again 21-22 days after being released. This will be the time with maximum amount of brood in the colonies. By this time three-quarters of the comb should be filled with honey for successful wintering. The number of frames needed for winter should be estimated (no more than 8 or 9) and saved. Surplus honey produced by the colony can be extracted. When the outside temperature is close to 7º С, it is possible to observe the number of frames needed for colony wintering. With the bees clustered closely on the comb, the size of cluster is determined correctly if bees cover both sides of the comb adjacent to the vertical divider board. It is necessary to have bees in the “street” between adjacent frame and the board.

 In queen-rearing colonies, reproduction control can be used to have the greatest number of young bees and as little as possible larvae under 3-days-old by the time of grafting. These conditions will be perfect for starting queen cells. Overcoming swarming is a part of the new technology as well, as described earlier.

The periods for continuous reproduction and no reproduction must be estimated properly. Brood presence has to be viewed as preparation for realization of specific work. Therefore, it is important to calculate when maximum colony population is needed. For example, in unfavorable periods when there is no nectar flow, reproduction should be stopped. Such intervention on colony life will make it much stronger. This becomes possible because bees that were born during broodless period were not producing royal jelly, and therefore can become long-living ones. They will stay physiologically young for about a year or even longer. They will start aging significantly only while secreting royal jelly. However, spring build up of the colony is very important and compulsory for colony health and productivity. It is more successful in warm weather.

Considering all possibilities provided by reproduction regulation, we can conclude that it can be 100% effective for releasing bees from varroa mites. This will be possible to do without any medication because the absence of brood eliminates the breeding of mites, while the adult mites only live 7 or 8 months. The only problem is wild bees that still have varroa so they or other unhealthy colonies could be a source of new mite infections.

The proposed method allows a beekeeper to halt all brood diseases, bacterial infections, and other disorders without application of drugs.

Swarming can also be controlled by reproduction regulation. Queens should be isolated in the end of summer. Following the nectar flows, queens should remain isolated to prevent the appearance of brood in winter and early spring.

Also, this technology can be useful for higher honey production and to prepare for rearing queens.

Queens that get isolated are able to save sperm, and stay highly productive longer. Application of reproduction regulation on 22 thousands of bee colonies has not showed negative effects on queen performance.

# Model for the effective use of

# reproduction management

The best location for c

reating a model apiary is an isolated island with good nectar and pollen sources. Natural shortages must be compensated by additional feeding, as a deficit is unacceptable. In a worst case scenario, pollen can be substituted by soybean flour, skimmed milk, dried milk, yeast and other protein products. However, it is not advisable to use substitutes as natural pollen and bee bread are best.

The number of bee colonies should correspond with nectar and pollen availability. This will enable us to see advantages of the proposed method, bees’ productivity, and their health improvement. Application of described manipulations in full will make all brood diseases disappear without any medication. Destroying varroa should be explained with more detail though.

During my research, information on varroa mites’ lifetime was not always confirmed, because colonies would “raise” young generation of mites. However, to get rid of varroa mites, queens should be isolated in all colonies simultaneously. For example, in the first part of July in high northern latitudes and in December in high southern latitudes. In this case mites will die in 7-8 months. This is an approximate lifespan, because mites are very unsteady in their development and affected by climate. This subject requires further study.

A model bee yard is best for demonstrating the method of technological regulation of honey-bees reproduction. It can be best studied in isolation. This allows us to ensure it can be realized. A model will show the best way for health improving manipulations.

 There is a threat for total loss of honey bees in the world. By studying our model for new beekeeping practices every beekeeper, expert or apiary owner, will learn ways for treating bees against diseases on all continents. A model apiary will be closed for external access, including beekeeping products, to obtain more accurate results of the experiment, less affected by extraneous uncontrolled variables. Our aim is improvement of bees’ health and production of bee products uncontaminated with medications.

While studying lifetime of varroa mites in a regular production situation I obtained controversial, or confounded, data. Specifically, young varroa mites came from other colonies where queens were not isolated. The variability sometimes reached 60 days, giving reason to doubt data accuracy. However, I am grateful for all the critics who helped me to understand the reason for such variability in the results. Thus, activities for varroa treatment are developed comprehending these adjustments.

In a model situation these confounding events are excluded. If all queens are isolated simultaneously, mites will be the same age. Thus, they will die off in the same time as well. Colonies will be free from parasites by spring because mites will not be able to survive through the long winter. This will enable all bees on Earth to be cured. The only problem would be to carry out simultaneous implementation of such action. Model apiaries should appear in each country. The first one in each country should be named by country name, and the following ones numbered based on creation sequence.

All activities in model bee yards should be well planned and controlled. Possible sabotage acts have to be prevented. Quarantined environments are essential. No beekeeping products should enter its territory, including frames, comb, brood, etc. Bees should not be shown to visitors to prevent their life disturbance. Bee yards can be visited only after receiving permission from apiary managers. All production operations can be demonstrated in an empty beehive.

Visitors should obtain a description of bees and beekeeper activities. They need to wear overalls provided by maintenance staff. They can only take documents, a handkerchief, and a mirror with them; no bags. Such visits can be paid. Visits to model apiary without an expert guide have no value and therefore are unacceptable. Each visitor should receive a book with comments and in-depth explanations. Such visits will be useful for beekeepers, interested in implementing this technology. Groups of experts could visit as well, but only after permission and in the presence of the owner. Such groups should leave their comments and suggestions.

# Contagious bee diseases and parasites are global problems.

One of the worst problems is varroa mites. It develops under influence of several factors. Climate and geographic location have a great impact. Each region is characterized by constant and changing conditions. Constant conditions are inherent to certain climate in general, for instance tropics, subtropics, marine climate, continental, dry, humid, etc. These conditions are important in mites’ life cycle. It is best-adapted to temperate climate of mid latitudes, where bees reproduce for a long time. These territories are also suitable for the mites’ development due to sufficient humidity, as it prevents drying out and death of mites. Hot and humid climate is good for mites, while hot and dry is deadly. In such locations it develops poorly and does not cause much trouble to the bees. In high latitudes with cold climate and short breeding period varroa mites are struggling to survive as well. Reproduction of bees is vital for mites. **These parasitic mites can only reproduce while bees are breeding**. No fauna species can survive without reproduction. That is why mites’ development is slower in northern climate, and they cause less trouble to beekeeping. This also explains lower attention to this problem. Natural reproduction regulation of honey bees helps them to get rid of this parasite. They can do this due to a shorter reproduction period and the longer life span of bees. A long living physiologically young colony of bees outlives the mites. But, they can get repeatedly infected from other colonies. The other big problem in the process of releasing the bees from mites is a habit of beekeepers to apply acaricides (drugs against mites).

New methods for treating bees against mites are usually accompanied by distrust and conservative thinking. However, complete destruction of mites will require orderliness and compulsory treatment measures in all apiaries. Even a small source of disease will bring the mites back. We should not hope that some new drug will kill all varroa mites. This is impossible; because acaricides (killing mites) are insecticides (kill insects, including honey bees). Mites and bees are both jointed-legged animals. Therefore, it is impossible to invent a poison that would kill the mites and had no harm over bees. Any increase in dosage or concentration of these preparations is harmful to bees. You should always remember that acaricides do not treat the colony of bees. They kill the mites and have a negative effect on honey bee health.

**Prevention and treatment** from varroa mites in Northern hemisphere should be based on stopping bee reproduction from mid July until mid April (in the Southern hemisphere – from mid February until mid December). This is true for high and low latitudes, where bees naturally stop reproduction. In low latitudes closer to equator, where queens lay eggs all year, reproduction can be stopped any time during the least favorable periods. Broodless periods should have same duration as in northern and mid latitudes. It is important to maintain the broodless period simultaneously on a whole continent or most of it territory. This will help to stop infection. In low latitudes timing should be agreed among local beekeepers.

Mites will die out during the broodless period. ***This way the whole planet can be saved from varroa mites. A continuous broodless period in low latitudes will also release the colonies from Tropilaelaps clareae, which life span outside brood is short. Most of its life goes on in bee’s brood, therefore it cannot survive in mid and high latitudes.*** Thus, application of technological reproduction regulation helps to solve this problem without any medications.

**Nosema** (a quickly-spreading disease that spreads across a large region or worldwide) requires close attention as well. It is caused by nosema apis, which often displays no symptoms. In certain conditions it develops clinical signs of a disease. This parasite is conditionally-pathogenic. It stays passive when the bee body lives in favorable conditions. However, parasite does not disappear. If a bee consumes some poison, its protective mechanisms get weaker. That is when this parasite can take over. This can also happen due to low quality food, poorly arranged winter nest, etc. Most often a colony of bees gets nosema in winter in conjunction with brood appearance. Such situation puts a heavy load on the colony. It is forced to maintain a temperature of 35C, which is hard to achieve in that time of the year. In order to raise the temperature, the bees start to consume more honey. Their gut becomes overloaded, which can cause involuntary bowel emptying. Also, the bees are forced to secrete royal jelly. Such disorder is good for the parasite. This can be stopped by isolating the queen from laying eggs in mid-July, and released when first pollen sources appear. In the southern hemisphere the queen should be isolated after the period of maximum amount of brood.

In this situation a colony of bees will mostly consist of physiologically young long living bees. It will go through winter without difficulties caused by brood. Bees in such a colony are able to live for more than a year. However, reproduction should continue sometime around mid-April. A long-term broodless period along with high quality food and proper beekeeping practices allows preventing many diseases of bees.

# Foulbrood

Many brood diseases can be easily treated using the technological reproduction regulation method. The queen is placed in isolating cage. In 21 days (24 days if drone brood is present) all adult bees are moved to a new disinfected beehive. A nectar flow is helpful during this process. No medications are required.

**Methods for treatment of other disorders are described in this book.**

**Viral diseases are also treated and prevented without any drugs.**

# The phenomenon of honey-bee reproduction biology

A new phenomenon has been discovered: honeybees in normal colonies never reach their potential longevity, but their lifetime can be greatly increased when reproduction regulation methods are applied. For the first time this characteristic was estimated by Mauricio in 1958. The maximum genetically programmed age for honey bee is 396 days. This author (Khmara P.Y.) has invented a way and equipment for reproduction regulation.

This new technology allows liquidating varroa mites due to their shorter than bees’ longevity. Extended lifetime of the bee is achieved by releasing them from royal jelly generation.

To save a colony from varroa mites, its queen has to be isolated (no brood is present) until all mites die. Reproduction of bees can be renewed after that. In such manner we can destroy varroa mites in the whole apiary, in a region, continent and in the world.

Other bees’ diseases can also be treated using reproduction regulation. For instance, disorders that are a threat to beekeeping due to lack of effective sanitation.

This phenomenon can be also useful for decreasing bees’ honey consumption during periods of dearth.

Reproduction should be stopped in summer to create better conditions for wintering of the colony. This will prevent the appearance of weak bees (the later in the fall they emerge, the weaker they are).

It is also important to use this concept to stop queens from laying eggs in winter time, which can result in colony collapse. In early spring this concept can be useful as well. Brood rearing during this period is more costly for the bees since they are weakened by the winter. With controlled brood rearing, bees that appear in spring weather are more viable, their brood rearing is easier and faster for the colony.

Reproduction regulation can be used to increase honey production when the nectar flow is short. Swarming and many other problems can be solved as well.

This new method is worthwhile to be included in beekeeping technology to increase productivity and efficiency of beekeeping industry.

# Brood of honey bees

This is the most costly beekeeping product. Its value is very high considering all the expense of its development. The amount of honey and bee bread goes down fast when brood is present. During broodless periods, a colony of bees consumes only a small amount of food. On the average, colony of bees in peace consumes about 15-30 grams of honey per day, or less than one kilogram per month. In June-July the number of brood is maximum. During this period bees consume between 22 and29 kilograms of honey per month.

Brood is costly but necessary event. Costs are explained by the need to feed the brood and fast aging of nurse bees.

Therefore, we should carefully decide when and how much of brood we need. These needs and operational conditions will vary in each case. Weather is an important characteristic that has a direct impact on beekeeping. It depends on a specific location of an apiary. All production actions should be consistent with weather conditions, which depend on parallels of high latitudes. In fall, this imaginary line is moving towards low latitudes. It is an interesting paradox, that conditions in high latitudes are more suitable for maximum life span of bees and their better physiological state than the ones closer to equator. It seems that a stable temperature regime of low latitudes would stimulate bees’ activity year round. However, it has the opposite effect. In low latitudes bees can reproduce year round, which is worse for their development. This creates a need for artificial reproduction regulation. It will help to liquidate diseases during rainy seasons and droughts in tropics.

Creation of broodless periods and periods of maximum reproduction will allow to overcome many problems in beekeeping. Naturally, more research on different continents would be required. Every territory has its peculiarities: temperature, humidity, landscape, wind rose, vegetation, etc. It is also important to see the factors that can cause pathological changes in bee body: honeydew, presence of poisonous plans, access to products of confectionary industry, etc.

# Reproduction regulation

All organisms on our planet are breeding. This is vital for continuing the species in successive generations. Living organisms are constantly adjusting to new environmental conditions. Reproduction regulation is an important adjustment mechanism. It is inherent for the bees as well. Processes that characterize this mechanism are very evident in colony of bees. However, they have not caught the attention of numerous research studies. Ancestors of honey bees possessed a hypobiosis mechanism that enabled them to stop or slow down breeding and other life activities. Most insects still have abilities for hypobiosis. Bee colony activities are also slowed down during inactive periods. This saves its life resources and extends life expectancy. However, this state is influenced by many factors, both predictable and unpredictable. They include location of the colony, wind, weather, air humidity, protective measures, availability of food and its quality, ability to maintain a cluster, and movement of bees between the combs. All these requirements are normally met by the bees while building comb.

Wax constructions in natural hives have architectonics that enables bees to get from the center of the nest to its periphery efficiently. In contrast, bees in modern bee hives are on framed comb, where only vertical movement of bees is easily achieved. Horizontal movement between combs is cumbersome. Movement between combs can be stimulated by the beekeeper by poking a hole in the center of each framed comb. This will help bees to form a winter cluster and change its shape and location depending on the colony needs.

Reproduction usually temporarily stops in unfavorable conditions. This is a natural phenomenon that should be better studied and used for the development of beekeeping. New technology will be more efficient economically and will be useful for improvement of bees’ health.

The reproduction regulation process should be studied in detail now.

A colony of bees stops reproduction in unfavorable seasons to survive. Their vital functions change in a regular sequence. In spring they resume and accelerate reproduction. Abundant warmth and food in this period enable them to do so. The queen is laying more eggs, synchronously with increasing day length, and later slows down with day shortening. This is obvious, since the number of bees starts to go down in mid-July in each colony. Queens lay fewer eggs, and in 21 days there are fewer emerged bees as well.

The process is logical. A colony reaches its maximum size to gather and store more food that will be used during winter. The brood nest size shrinks, and more combs are filled with honey to enable bees to survive winter. Wild bees usually stop reproduction when they have an abundance of honey. While the beekeeper extracts stored honey in the end of the honey season, wild bees keep and protect their honey stores. Most often their comb containing honey is attached to the top of the nest. Brood is normally below the honey. Thus, cooler space is reserved for rearing brood. During a good nectar flow the size of comb with honey is expanding, forcing the queen to lay in brood cells lower down. When the day is getting shorter and air temperatures decline, queen has no space left to lay eggs. Therefore breeding is naturally stopped and most bees do not feed larvae in the end of summer, or are only minimally involved in brood rearing. Thus, bees that live through winter are physiologically young because there is no brood in the end of summer and beginning of spring.

Traditional beekeeping technology creates substantially different conditions than bees encounter in nature. Honey is extracted as soon as bees make their stocks. The queen’s work is rarely limited by the size of the nest. Usually there is a secondary nectar flow that promotes more brood. Access to sugar syrup allows them to make stocks for winter and reproduce fast. Later, as the weather gets cooler breeding slows down, but brood is present for a long time. Bees that are born in this period are poorly developed. They have less protein, and thus are physiologically older. They consume more food, making their generation more costly. We still can observe some natural reproduction regulation, when a queen stops laying eggs in autumn. With some thought, this phenomenon can be used for improving our beekeeping technology. Bees that live in cooler climates start preparing for winter earlier, have physiologically younger bees than the ones in the south, and thus have better chances to survive the winter. All this is possible because the broodless period in such colonies is longer. On the contrary, in warmer climates brood is present for a long time. It leads to rearing many generations of bees and substantial exhaustion of colony’s strength before winter. If winter is short, they can manage to survive. For example, in Siberia, the average bee colony can survive winter covering 8 or more frames. While on the coast of Black Sea 4 frames can be enough to have for wintering. The period, when bees are not flying is 14 or 15 times longer in the north. Experienced beekeepers have noted that colonies that did not have brood in fall survive winter better. Thus, suspension of reproduction in the middle of summer is useful in all respects. There will be fewer dead bees in spring, colonies will consume less honey, and will be more productive in spring. The worst situation is brood presence in winter. Some beekeepers believe that winter brood is a good sign. But let’s imagine what is going on in a cluster if a queen starts laying eggs. The colony’s immediate reaction is to increase the temperature. To do so, they need to consume more honey. Increased feeding fills guts with feces faster. Larva appears in 3 days, and must be fed with royal jelly. Generating this substance, bees’ bodies are losing protein, speeding up aging. In 3 more days larva will need honey, bee bread and water. There is no bee bread in winter cluster. It is located on the periphery, where bees are often not able to use it due to the low temperature. In this situation bees are forced to produce more royal jelly to substitute bee bread. Bees weaken and age very fast in this situation. Due to the difficulties with rearing early brood in cold weather, the colony is not ready for expanding in spring when weather conditions are most favorable. **This should be the time when queen is released from its cage, where it stayed from the mid-summer till spring.** As a result, a colony that has not raised brood since mid-summer will mostly consist of physiologically young bees in the beginning of winter, and they will not age much when spring arrives. They will experience only calendar aging, but not physiological. This is easy to confirm in practice. Two colonies with similar characteristics can spend winter in different ways: one is being left on traditional technology, and another with its queen isolated. Advantages of technological reproduction regulation method have been confirmed by more than 17 thousands of bee colonies. The benefits obtained include better colony condition on the winter and increased productivity.

The proposed method also meets the biological needs of the bees. It was created after research of natural processes in bee colonies.

It is obvious that traditional technology has flaws that resulted from unlimited possibilities of manipulations in the beehive. One of them is excessive honey extraction, which became a common abuse of traditional technology. The foundation for creating technological reproduction regulation technology was the comparison of processes in wild colonies and those kept by people. This new technology will allow creation of optimal conditions for colony life and beekeeper prosperity. ***Beekeeping efficiency will be greatly supported.***

# Physiologically young bee colony as a result

# of reproduction management

The main achievement of reproduction management is a physiologically young colony and a maximum life span of bees. This requires temporary planned isolation of the queen, which stops her from contact with comb and eggs laying, but gives worker bees the opportunity to serve her constantly. Bees’ longevity management, disease prevention, health improvement, and increased productivity are the main objectives of this effective beekeeping technology.

Wild bees have a system for natural reproduction regulation. Queen slow down and later stop laying eggs during the swarming period. Reproduction biology of honey bees has four stages:

1) Egg, laid by the queen;

2) Larva hatches out by secreting special enzymes that dissolve the egg shell. The larva is not fed royal jelly until it is completely released from its shell;

3) Adult bee emerges;

4) Swarm - new colony is born.

Breeders sometimes try to breed bees that have a low tendency to swarm. This is unlikely to be achieved. New bee colonies can only be created through swarming. Thus, swarming genes will always be present, although they are not observed unless certain conditions are created. These conditions, combined with genetic information, are responsible for the natural appearance of bee colonies. Delay in egg laying by the swarming queen creates an environment for the emergence of long living bees in a swarm colony. They become the main workforce of new colony, which explains the high productivity of natural swarms. High longevity depends on whether a bee was secreting royal jelly and how much of it. In a colony where brood must be fed, adult bees have a short life expectancy because most of them become physiologically old as a result of their feeding brood. Understanding the difference between the physiological and calendar age of bees helps us to manage natural processes in a bee colony. This is important for effective treatment of diseases and creation of better beekeeping technology, which will enable steady development of the honey industry. Role of honey bee as a pollinator will also be enhanced.

Let’s draw our attention to the honey bees’ hair-covering. It is virtually a flying brush, which moves pollen from flower to flower, performing cross pollination. This function is extremely important for agriculture, and it is perfectly performed by the bees. Unfortunately, this role is not fully utilized by agronomists and farm managers who produce insect-pollinated crops. Bees that did not feed the larva are physiologically young. Therefore, brood is a factor that speeds up bees aging. Intense work of glands secreting royal jelly exhausts a bee’s body. This substance is produced from protein material. A critical deficit of protein is a main cause of bee death. Forage work, such as water delivery, collecting nectar, pollen, and propolis, does not affect bee longevity much (El Dib, Mayer, 1950). Reproduction should not be stopped *during* a strong and continuous nectar flow. It is worth doing *before* the nectar flow, or during a short one. With some creativity and experience, a beekeeper will be able to use the nectar flow in the best way without weakening the colony.

The application of this technological reproduction regulation method should enable the beekeeper to use chronologically old bees to feed the brood. This is a basis for the most efficient production of beekeeping products and improvement of colonies’ health. It enables a bee to live a long productive life. Brood presence in a colony causes young bees to age during the very beginning of their life because they are forced to secrete royal jelly. According to this new technology, a worker bee will perform brood rearing functions when up to 200 or 300 days old. Such a long life will enable every bee to work for the welfare of the colony and beekeeping industry.

# Saving the physiological youth of bees for sanitation

# and economic benefits in beekeeping.

When the bee emerges as an adult, its calendar and physiological ages are the same. The aging process of the bee can be halted so that it remains a physiologically young bee, regardless of chronological age. We have earlier described such a possibility. Saving physiological youth of the bee for a long time, for instance a year, enables us to change beekeeping technology. The most efficient way is to obtain royal jelly from 10 months old bee, instead of newly hatched one. This can be achieved through regulation management. According to this method, the broodless period lasts about 300 days. It can be longer or shorter: between 290 and 315 days. As a result, a colony of physiologically young bees will be created. It will not waste its resources on multiple bee generations, and will have stronger health. The bees are enabled to live a longer life while staying physiologically young. In the end it will feed larvae with royal jelly, which consists of its body matters, and die. ***The main purpose has been achieved: bees are able to live long healthy life, age naturally, and reward the apiary owner with high quality products that are not contaminated with medicines.***

Therefore, it is recommended to apply reproduction regulation in certain periods. This is done by separating the queen from brood cells.

If there are no eggs because their queen is absent, bees will start rearing emergency queens. When a queen is caged (for example in a Titov cage or a traditional queen shipping cage) bees may start emergency queen cells as well. Additionally, queens cannot stay alive in such a cage long. Therefore, these scenarios are not appropriate for reproduction regulation. It is necessary that the queen remain in good regular contact with all bees, but prevented from laying eggs.

Special equipment has been invented by Khmara P.Y to make it possible for the queen to stay isolated for a year or more. This cage is fully accessible for worker bees, which can enter and leave at will, serving the queen and receiving queen pheromone. In this case queen isolation has no adverse effect on the colony. There will normally be no emergency queen cells, although possible in strong colonies, and no laying workers. It is also important that the queen is well served and remain in the center of the nest, especially in winter. She is well fed and warm while the cluster moves up and down.

Therefore, the queen stays in the colony performing all necessary functions except for eggs laying.

A broodless colony with an isolated queen behaves similar to one with a free queen. The queen is present and performs its main function: uniting bees in a colony so they perform all vital functions of the super-organism. Queen mandibular pheromone is very attractive to the bees. Her body also exhales a specific aroma, which contains a special agent that inhibits workers from starting queen cells, suppresses ovary development in worker bees, and restrains the appearance of laying workers. It has been shown that this substance consists of a fatty acid that is present in food produced by worker bees for larva feeding.

Queen pheromone is present all over her body when she is taking care of herself. Young bees that serve the queen lick off this substance and spread it to other bees in the colony. Thus, bees and the queen are interacting; she is able to perform all the functions in the Khmara cage except for laying eggs.

Many beekeepers are asking if queen will be affected by the inability to lay eggs for a long time. No such effects have been noted so far.

Queens often lose partial egg-laying qualities during shipment, possibly as a result of temperature shifts during her transportation. Check her performance in nucs, especially small ones, where risk is greater that the temperature destabilizes. When the queen is placed in a strong colony with optimal temperature control, she is unlikely to get ill or lose her ability to lay eggs. This can be easily verified.

Queen pheromone affects bees’ behavior during comb building and collection of nectar, pollen and propolis. The same pheromone inhibits the workers from laying eggs, and slows down swarming. Therefore, contact between worker bees and the queen supplies the whole colony with this important chemical signal. When it is missing, bee colony as a super-organism experiences a pathological condition – it feels orphaned. When pheromone output diminishes, a supersedure process is initiated and the colony starts building queen cells. Since this is a convenient way to replace the failing queen, the colony should not be disturbed at this time. New queen cells were started by the bees that did not obtain enough pheromone. The queen cells can be destroyed by the bees that have better access to queen pheromones, or if they are disturbed. Supersedure queen cells look similar to swarm cells, so one should be sure to understand the condition of the bee colony well. To avoid mistaking supersedure cells for swarm cells, check for other signs of preparation for swarming, such as the colony stopping its work while other colonies seem busy. A swarming colony usually builds many queen cells, while supersedure process initiates only 1 to 3 queen cells. If there are still doubts, check the number of eggs laid by the queen. During supersedure the queen does not stop laying and continues to work. During the last days prior to swarming the queen loses size and weight, and lays few eggs. For more detail on swarming, see the special chapter in this book.

Bees that do not feed brood stay physiologically young and have higher longevity. Presence of brood will shorten their life to 35-37 days. Their natural life expectancy when not required to feed brood is more than a year.

Physiologically young bees have a prospect for a genetically programmed long live if they save the most of protein substance, which was synthesized the age of 18 days. There are two types of aging: calendar and physiological. Calendar age is a number of days from its appearance. Physiological age is correlated to the amount of protein that remains in bee’s body.

# Two ages of a bee

We can operate with such concepts as manageable and uncontrolled ages of honey bee. Physiological age can be managed. At the time of emerging, calendar and physiological ages are the same. Calendar age changes with passing time and cannot be controlled. Physiological age depends on body condition and can be managed when using technological reproduction regulation technology.

Reproduction regulation is a natural event that shows the unique biological ability of honey bees. It has always existed, but no one has paid much attention to it. Thus it can be considered a discovery. It is intrinsic to bees in all geographical regions. However, it is more evident in environments where it is harder for them to survive.

In low latitudes, where bees’ activities are less related to season changes, reproduction takes place year round and its regulation is relatively absent. Reproduction management is required to improve bees’ health, stop swarming, save food, and produce non-contaminated beekeeping products (bees are cured without application of drugs and medication).

In low latitudes this method is used for the same reasons. It can be applied in a number of periods, and have great influence on bees’ productivity due to rich forage resources.

***It is an interesting paradox: reproduction regulation is most needed the most in places where it does not take place naturally. It creates possibility to save physiological youth and maximize productivity of honey bees.***

Two ages of bees can be presented in a shape of ruler with a movable ring on it. The ruler represents the calendar aging of a bee, while the ring represents physiological aging. The ring is moved by synthesis of royal jelly in the body of honey bees. When royal jelly is produced, the ring starts moving, and when bees do not feed larvae the ring stops.

Royal jelly synthesis stops when the queen is isolated. When the queen is released ring starts moving toward aging and death.

 Physiological aging, manageable

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|  |

 Calendar aging – uncontrolled

***Technological reproduction regulation seeks to save and use physiological youth of honey bees during later periods of their chronological life.***

Management of physiological age is directly related to reproduction regulation. It is very useful to save physiological youth until chronological old age, when the protein reserves of bee’s body can be used. This can be achieved by having long period without brood. Long broodless period will also be useful for curing bees from diseases without medication, efficient use of food, and production of high quality beekeeping products. One of the most important achievements of this new technology is honey and other beekeeping products uncontaminated by drugs.

# Bee lifespan

The larval stage takes up most of phytophagous hymenoptera insects’ life. Adult insects emerge being sexually mature; males die after mating and females after laying eggs. Some butterflies have undeveloped snouts, and cannot eat. This is typical for swifts and moth. Bees generate royal jelly using matter that was accumulated during its larval stage. Thus, bees stay physiologically young until they start to produce royal jelly. Philips said: “bees are like batteries that cannot be charged after being used up”.

Drones emerge ready to mate with the queen and die after that. Drones that fail to mate are forced to leave the beehive before the wintering period. A queen obtains royal jelly during the larval stage and as an adult while producing eggs. Thus, royal jelly is a basis for bee reproduction. Bee life totally depends on the presence of materials for royal jelly production. Their absence means death.

The main task for a beekeeper is to maintain a technology that would allow bees to use this valuable potential later, when they become older. Bees should stay physiologically young longer. This will allow them to work much longer for the benefit of the colony and a beekeeper. This concept is described better in chapter “Two ages of honey bee”.

# Uses for the Khmara queen cage

First, the invented devise enables a beekeeper to liquidate varroa destructor.

**Varroa destructor** is an invasive disorder that affects adult bees, larvae and pupa of worker, drone and queen bees. Varroa are parasitic mites that feed off the bodily fluids of bees in all growth stages except egg. A female mite usually parasitizes on adult bees. Mites have four pairs of well-developed legs that enable them to move fast in the nest of honey bees. The mite bites through the exoskeleton of the adult bee or larva and feeds off hemolymph, which lowers its protein content by between 1.6% and 2.3%. Because of this, fat and organs of honey bee become undeveloped and its longevity goes down. On adult bees, mites are most often observed between the bee’s head and thorax, the thorax and abdomen, or between the first segments of the bee’s abdomen. Between 1 and 5, are rarely up to 8, mites can parasitize one adult bee (drone, worker or queen). Between 12 and 20 parasitic mites have been observed on worker or drone pupa.

Varroa mites breed in drone or worker brood cells. Their reproduction is connected to the biology of the bee colony. Female mites enter worker brood cells 1 day before it is capped (3 days for drone brood) and lay eggs. Up to 5 eggs can be laid in worker brood cell (6 in a drone cell). Usually a female mite lays one egg a day. Female mites develop into adults in 8 or 9 days, and males in 6 or 7 days. Female mites are inseminated in the cell before the worker or drone bee emerges. Only mites that hatched out on drone or worker prepupa develop completely. The exoskeleton of bee pupa becomes too hard for young mites to bite through and they die from starvation. Male mites die in the cell after mating. Each female mite can live through 3 egg laying cycles. Female mites that appeared in summer can live up to 6 months, while mites born in the fall can live up to 7 months (P.Y. Khmara, 2005). They spend winter living on adult bees. The number of mites in a colony of bees is lowest in winter, and highest in fall, because mites breed in worker brood in spring and fall and on drone brood during the summer. When air temperatures increase to 17°С female mites become active. When the temperature warms to between 19° and 27°С, the mites try to get to the warmest place in the hive. When the temperature is between 34° and 41°С, the mites seek the coolest place. Temperatures above approximately 43°С cause chaotic movements of mites. They die in an hour and a half in direct sunlight when left on a flower. However, some mites can survive up to 5 days and use this time to resettle. Mites do not breed in colonies of bumblebees, wasps or lone bees, but they have been found on these insects (V.L. Salchenko, 1975). Thus, mites are spreading through infected bee colonies, packages of bees, swarms, drones, and uncapped drone brood. A healthy colony can become infected with mites through robber bees, during swarming, from drifting bees and drones. Varroa mites can transmit American foulbrood, septicemia, colibacteriosis, Hafniosis, acute paralyses, sacbrood, and other diseases. There is no way to completely cure a colony of bees from varroa mites using medication. All existing methods for mites’ destruction cannot clear the colony completely. The main reason for that is that mites and bees are articulated. Acaricides, or miticides, are insecticides and are harmful to bees as well as mites. This makes it impossible to apply doses that would kill all the mites without also destroying bees. The only way to get necessary result is to lengthen the bees’ life span to that greater than mites’. Bees can have necessary longevity when reproduction regulation is applied. In this case, mites die due to old age. This is natural approach that will always be effective. Parasites become resistant to medication that is applied for a long period, and it therefore becomes inefficient. The new proposed method will not require any changes in the future.

The main achievement is that this new treatment releases a bee colony from all mites, and is not harmful to the bee itself. On the contrary, acaricides are hazardous for the bees. Trying to kill as many mites as possible with acaricides is usually deadly to bees too.

The number of mites should never exceed 4% (4 mites per 100 bees). Since varroa mites propagate only in bees’ brood, it is logical that stopping bees’ reproduction will make it impossible for mites to breed as well.

To be able to do this, we must control extinction of mites. It should begin 150 days after reproduction has been stopped. To measure the number of mites in a hive, white heavy paper is placed on the floor of the beehive. Every 5-7 days the paper is taken out and the dead mites are counted. A colony is free from the parasite if no mites are observed for 2 or 3 checks in a row.

Let’s now look at the main scheme for killing varroa mites.

Health-improving manipulations require queen isolation. If a colony is treated for the first time, the number of mites after 22 days of queen isolation should be measured. No additional treatment is needed if mites are observed on fewer than 4 % of bees. Heavily infected colonies should be treated with a commercially-available acaricide once. If there are too many colonies or for some reasons cannot check the volume of invasion, use an acaricide once as well.

Mites will die in 200 days after queen isolation, and spring brood will be healthy.

A healthy colony can get mites from other bees in June. Considering the fact that mite-free colony is surrounded by the infected ones, it is impossible to guarantee that it will not get mites again. Thus, a long term effect can be achieved when this method is applied on large territories. Ideally it should be performed on the whole continent. Studying the history of animals and people treatments, the most difficult task would be to find methods for complete recovery and organization of their implementation.

Bees on our planet can be saved from varroa mites, but it will require a well organized action. First of all, a **model** apiary should be created. It will consist of certain number of colonies, preferably located on an island, remote enough from the continent. They will be made healthier with the help of the reproduction regulation method. Data, obtained from such an apiary will be used to create instructions and rules for new beekeeping technology, which will enable production of non-contaminated products, productivity growth, health improvement, etc. These instructions have to become obligatory for all produces, which will enable simultaneous application of same methods on large territories. This will be a beginning of beekeeping without diseases and medication. Liquidating varroa mites is the main purpose for simultaneous execution of described rules. Application of invented devise – queen isolation cage - on large territories will help to obtain clinically healthy colonies. And beekeepers will be released from worries about varroa mites.

Regulation of bees’ reproduction, using queen isolation cage allows us to:

1. reconsider prevention and treatment methods without medication;

2. make substantial changes in beekeeping technology for higher productivity;

3. improve working efficiency of beekeepers and branch economy.

 Higher efficiency will be achieved through higher bees’ productivity and lower food consumption (honey and pollen). Cost of medication will become zero. Healthier colonies will be more productive, since there will be no quarantine actions. Beekeeping will be released from varroa, which now causes constant trouble and expenses. Swarming, which lowers bees’ productivity will be greatly reduced as well. This means health improvement becomes very cost-efficient, because once purchased the queen isolation cage works like “perpetual motion machine”, and stays effective for years. Beekeepers using this device according to the instructions have no need to worry about buying medicine. It is also important, that no harmful contaminants are getting into beehive and beekeeping products. It is near 100% effective. Lower effect can be a result of insufficient knowledge, mistakes, untidiness, or poor sanitation. Proper application of the isolation cage will allow obtaining pure beekeeping products from all colonies. Regarding honey purity let’s remember that honey causes allergies. An assumption that people are allergic to a certain types of honey is not accurate anymore. It is now suspected that allergies are caused by honey contaminants such as antibiotics, sulfanilamides, acaricides, etc. The solution is obvious – such substances should not get into honey. Such opportunity is provided by sanitation technology that uses the queen isolator and no drugs.

The Queen Isolator will enable beekeepers to treat all infectious diseases of honey bees. They will not need to spend money on medicine, and will be able to produce pure products without harmful to people contaminants. Application of reproduction regulation will make varroa mites disappear in one winter. Neighboring beekeepers will see the advantages of this method, and start using it too. Thus, there is a chance that varroa mites will disappear completely. When this aim is achieved, the Queen Isolator will be useful for other purposes.

# Application of Khmara Queen Isolation Cage

This equipment can be used in Dadant-Blatt, Roje-Delon, Langstroth, traditional Ukrainian and other beehives systems. In movable-frame beehives one cage can be used for single box and two when two boxes are used. In this case two cages are connected by blind holes, creating single space for queen and bees. Large walls of isolating cage are parallel to nearby comb, and should be placed 6 millimeters from its surface. To stop reproduction, queen must be caught and placed to the isolation cage through special opening. After the queen is caged, the entrance must closed. The Isolator is placed between comb frames such that it is in the middle of the hive and 2 centimeters lower than the comb.

Application of reproduction regulation method can cure bee colony from most diseases:

1. Varroa mites. This effect is based on the difference of life span of honey bee and the mite. Mites can propagate only in bees’ brood. Thus, when bees stop breeding, mites cannot do it automatically. Mites die when their life resource is exhausted. Bees are released from parasites. No medication has been used.
2. Tropielaps clareae;
3. Euvarroos;
4. sacbrood;
5. viral chronic paralyses;
6. acute paralyses;
7. Morbus alae obscura;
8. American foulbrood;
9. European foulbrood;
10. foulbrood, caused by Вас. Paraalvei (false foulbrood);
11. powdered brood;
12. septicemia;
13. hafniosis;
14. salmonellosis;
15. chalkbrood
16. aspergillosis;
17. nosema prophylactics in winter time;
18. larva and pupa nosema;
19. Tracheal mites.

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*Description and figures*

The Queen Isolating Cage is shaped like a box, with separating grids on the walls. These walls are 10mm apart. The sizes of openings are 4 by 15-30mm. There is also an opening (14mm diameter) for queen entering and exit near the middle of grid. There are special spacers on the inside to prevent walls from bending in. The Isolator consists of two identical pieces. Queen is placed inside through a special opening, which has to be sealed than.

 The Isolator with queen is located in the middle of the nest between combs. The distance between comb and isolating cage should be 6mm. Bees are free to enter the cage to take care of the queen and can exit any time. They are constantly present in the isolating cage, fulfilling all her needs. Since queen is larger than worker bee, it cannot walk through the same opening, and has to stay in the cage all the time, which prevents her from laying eggs.

This equipment can be used in Dadant-Blatt, Roje-Delon and traditional Ukrainian beehives systems. In Roje-Delon beehives, the same cage is turned vertically. To stop reproduction, the queen must be caught and placed to the isolation cage through special opening. When queen is caged, the opening must be closed.

 Bee colonies’ health improves greatly as a result of isolating cage application. Since no medication is used, we can obtain pure beekeeping products.

***Description of drawings***

Fig.1 shows the general appearance of the Isolating Cage. Its size is 360 by 240 by 10mm. The cage has an opening for the queen and numerous slot-like openings large enough for worker bees to enter and exit freely, but small enough to keep the queen isolated from brood comb. Fig. 2 shows a standard Dadant-Blatt frame with the Isolating Cage inside. The size of openings for workers entrance is 4 by 30mm.

Fig.3 shows parts of the Isolating Cage.

 In fig. 5 we can see an Isolating Cage that is taken apart. Special holes on narrow sides on top and bottom are shown. If you open these holes and connect two cages, queen will be able to walk freely up and down.

The Cage inserted in the frame is shown on fig.6.

# Technology application

 Projected results from reproduction regulation method are:

1. Guaranteed prevention of swarming;

2. Guaranteed absence of brood in winter; destruction of varroa mites; prevention of reproduction in late fall and early spring;

3. Timely suspension of reproduction before main nectar flow;

4. Reproduction can be stopped in June if no nectar flow is expected;

5. Treatment of infectious diseases.

# Creating a colony of long living bees

It is good for bees and advantageous for a beekeeper to ensure a short reproduction cycle and long broodless period. It enables us to carry out effective prevention and treatment measures against infectious disorders and cut expenses by conserving royal jelly, honey and bee bread. Technological reproduction regulation is done using the queen isolating cage, which has been invented by Petro Y. Khmara.

 Most beneficial schedule for northern hemisphere is to isolate the queen from 15th of July until stable warm spring weather. In southern hemisphere this should be done around 15th of February. Such an approach allows us to build a colony thatconsists mostly of bees that appeared 27 days before and 21 days after queen isolation. Therefore, colony will consist of physiologically young bees.

 A colony of long living bees can be created using queen isolation. Egg laying activities should take place in the most favorable period: from 1st until 21st of June. The dates can be adjusted depending on local conditions, but should stay close to the optimal. Strong nectar flow should be utilized in full.

The described reproduction regulation allows cutting costs and can increase profitability greatly. Along with these benefits, the bees will be protected from many infectious diseases.

# Formula

A colony of long living, physiologically young bees appears naturally in high and middle latitudes. Technological reproduction regulation has been developed to utilize and improve this process. The queen isolating cage creates conditions for a long broodless period. This allows saving the physiological youth of bees, lowers consumption of royal jelly, honey and bee bread, and increases profits due to higher productivity. It makes prevention and treatment of infectious diseases possible .

In low latitudes it is also useful to apply artificial reproduction regulation method. Benefits from this method will be improved even more in the future.

#  Diseases curing technology

***Brood diseases, which can be cured with new technology, are:*** American foulbrood, European foulbrood, false foulbrood, chalkbrood, aspergillosis (affects brood only if clinical symptoms are present), and sacbrood.

This health improvement plan requires queen isolation for 21-24 days. As a result, there will be no worker and drone brood.

After this period, colony must be moved to a disinfected beehive with pure comb. The old beehive, comb and sometimes surrounding territory needs to be disinfected as well.

***Diseases of adult bees include*:** hafniosis, salmonellosis, colibacteriosis, septicemia, melanosis, candidosis, chronic viral paralyses, acute viral paralyses, nosema, and tracheal mites.

In this case queen must be isolated for 9 days in order to obtain capped brood, which has to be moved to a well insulated beehive (at least 4 comb frames). No worker bees should get into disinfected hive. These operations should be performed in warm or hot weather (between 25° and 30°С). The hive entrance should be closed with a screen for 6 or7 days. After all bees have emerged, they are moved to another beehive, and old comb and beehive are disinfected. During the longest broodless period, which takes place in winter time, it is possible to cure a colony from varroa mites.

***New methods of beekeeping technology are healing by their nature.***It is well known that varroa mites can breed and develop only in bees' brood cells. The bee queen lays an egg, which starts new bee life. A female mite lays eggs on bees’ prepupa, and stays in the cell until her offspring and a bee emerge. It is obvious that a young bee, which emerged in such conditions, is weakened by the parasites and sometimes is not even viable. It can die and rot in the cell. This might look similar to foulbrood.

# Pure products of beekeeping

*Health protecting abilities of feral bees*

Most often feral bee colonies lived in upper part of tree hollows. The foundation of such nests would be its ceiling, because it is easier to stabilize temperature there. Wax constructions would be attached to the ceiling as the warmest and cleanest place. Dirt and microbes, cleaned by bees from the comb, are falling down. Deep hollows would prevent bees from contacting this dirt again.

In traditional manmade beehives, on the contrary, there is no space between frames and the floor. Pieces of dirt stick to bees’ hair coat when they walk on the floor. In this situation dirt and harmful microorganisms return to the nest. Thus, hairs on the bees' body, which are so important for pollination, gets dirty.

 Usually, there are no, or very little of disease agents in a healthy bee colony. As a result of experiments, Gardi A. (1978) came to the conclusion that a colony would show no symptoms of American foulbrood, while the number of spores was less than 50 million. This level allows bee colony to clean the hive from dead larva. Thus, it is important to prevent hazardous dirt on the floor from returning to the nest. Bees are genetically designed to clean beehive from dirt and dead larvae. It is very important for diseases prevention.

Wild colonies usually would not use wax combs from a perished colony. It is well known that more often a colony dies during wintering. Bee colonies do not change their location in spring time. In summer, honey and bee bread left in the hollow are destroyed by wax moth, bears, martens and other animals. Thus, if the colony died due to an infection, it wouldn’t spread to others.

Most infections cannot be spread while drones and queens are mating. Drones that impregnate queens die immediately due to copulation (reversing of genital organ). Thanks to that it cannot transfer infection to another colony. Queens do return to the nest, but they rarely can be infected by drones. Drones are mostly healthy, because they appear in strong colonies.

# Some facts about infection mechanisms

Infectious diseases are becoming more widespread. Some apiaries are struggling with several diseases in the same time. One of the reasons for that is the large number of the colonies kept at the same location. That promotes drifting of bees between hives and robbing behavior, which spreads infections.

Limited beehive space, which is occupied by the colony during the most active period, also helps spreading the diseases.

Swarming can also be considered a factor for infections spreading. Colonies that are damaged by varroa mites can swarm. Other colonies abscond due to some unusual and constant irritant. Location change brings them temporary relief, because brood and most mites stay in the old nest (up to 70%). This pathogenic swarming can take place in fall – when mites’ population reaches its maximum. A long warm autumn can help rapid growth of mites’ population, which often becomes a reason for mass death of bee colonies. Transportation of package bees and queens, moving apiaries while changing owners, or for harvesting honey, can also result in infecting other apiaries.

Diagnosis of diseases in apiaries is often late due to the lack of symptoms knowledge. Therefore, it is hard to control migration of infections.

***Storage of infections***

All parts of beehive can contain invisible remains of infected food when it is occupied by diseased colony. If a queen bee lays an egg in infected cell, future larvae can get sick and become an additional source of infection. It is extremely difficult to disinfect all combs using traditional technology. This became the main reason for diseased apiaries.

Effective health improving methods need to be found to fight growing number of diseases. The possibility of disinfecting all beehive parts plays an important role as well. Beekeepers have been searching for such methods for a long time. For instance, Prokopovich (1827) suggested relocating a colony to another beehive to help cure foulbrood. A diseased colony would be kept hungry for 2 days to make it use up infected honey reserves in bees’ stomach.

Georgievsky (1936) offered an original method for treating a colony against foulbrood. It is more labor-intensive. He suggested installing empty combs into new beehive along with foundation. One day after transferring the bees the comb with contaminated honey would be taken away, preventing the colony from spreading foulbrood. Some scientists came to conclusion that infected colonies have to be burned.

Relocating colony, which has no brood because queen is isolated, will be a very effective way to treat foulbrood.

Appearance of antibacterial medicines, especially antibiotics, resulted in unexpected consequences. Causative agents of diseases were slowly adjusting to drugs applied. Higher doses of these medicines destroyed bees’ immune system.

Additionally, beekeeping products became contaminated with drugs that can be harmful for people's health. Some countries banned contaminated honey import.

Bees have existed in the wild for a long time because of natural reproduction regulation. This process used to be influenced by such factors as drought, diseases, cold weather, and lack of nectar sources. Now, it is important to apply technological reproduction regulation. Diseases should be treated through queen isolation as well. This means total renunciation of medicines.

This makes treatments more cost effective since, once purchased, a Queen Isolation Cage works like “perpetual motion machine”, and stays effective for years. Beekeepers using this device according to the instructions have no need to worry about buying medicine. It is also important that no harmful contaminants are getting into beehive and beekeeping products. It is near 100% effective. Lower effect can be a result of insufficient knowledge, mistakes, untidiness, and poor sanitation.

# Precautions and treating diseases

(Treating brood)

***American foulbrood***

This is an infectious disease that causes mature larvae and prepupa to die. Its spores are very resistant to physical and chemical factors. They become even more viable in honey, dead larvae, and especially in wax. Boiling wax in an open container kills these spores only in 5 days. They are destroyed in autoclave in two hours under the temperature of +127º С and pressure of 0.5 atmospheres.

Dead larvae are the main source for infection. In the colony this disease is usually spread by young bees that clean cells and feed larvae. Infection expands in an apiary through brood, hives, wax foundation, honey, pollen, bee bread, beekeeping tools, artificial foundation, shipped queens and bee packages, and bees’ theft. You should never feed your bees with honey and bee bread of an unknown origin. Clinical signs of foulbrood appear in June-August. All breeds of bees are equally receptive to American foulbrood. At first you will note sick larvae in different parts of beehive. Later, scattered brood of different ages appears, some caps are sinking down. Rotting bodies of dead larvae have glue-like consistency, smell like joiner's glue and stick to cell walls, making it hard for bees to clean them up. Ill colonies have poorer performance due to lack of young bees. Without proper treatment colony is likely to die. Diagnosis should be based on study of symptoms and lab analyses. Quarantine situation is announced in a radius of 5-7km around infected apiary.

***European foulbrood***

This foulbrood usually attacks uncapped brood. Most often larvae die being four days old or a bit older. This most often happens in spring. Causative agents of European foulbrood are resistant to environmental causes. At room temperature Streptococcus pluton can live for 3 years in dead larvae, stays in empty beehives for 45 days, in wax – up to 65 days, 84 days in water, and up to one year in bee bread. Spore of bacillus alvei can remain in dead larvae for more than 20 years. In wax it can be killed by temperature of +120°С in 2 hours. Streptococcus apis stays in comb, wax and honey for 265 days. It can be killed by a temperature of +60°С in several minutes; in 30 minutes it dies in a 2% solution of chloride lime. This infection is found in all climatic zones and on all continents. European foulbrood usually appears in spring, when colonies have a lot of brood. This weakens bee colonies, and lowers their productivity. Disease can have obvious symptoms or be in a hidden form. The main symptom for European foulbrood is presence of dead larvae, which is easy to spot during hive observation.

The first sign of this infection is movement of larvae in the cell. Healthy larva usually lies in the shape of half-moon or a ring and has well-marked nacred luster. Ill larvae are usually stretched along the cell, loose luster and turn grey-white or yellow. Later they become brown, constantly getting darker. A smell of rotting meat appears if bacillus alvei is developing in these bodies. Dead larvae have sour smell, which is different from American foulbrood.

The best preventive measures against European foulbrood are selection of strong colonies, good supply of high quality honey and bee bread. Bee yards should be located in dry, well lit spaces, protected from wind.

***False foulbrood***

This infectious disease usually harms 5-8 days old larvae (capped pupa). Adult bees do not get sick but can be bacteria carriers. Causative agent is Васillus Paraalvei. It is resistant to high temperatures and chemicals. Virulence of different strains is not the same and goes down when cultivated on nutrient solutions. This disease weakens colonies of bees and can cause them to die. It appears and spreads like other foulbrood infections. Symptoms are similar to chronic European and American foulbrood. Caps on brood become sunken at first, but then go back to normal. There are no holes in caps, which is the main difference from American foulbrood. Dead uncapped larvae are thrown away by worker bees, while capped ones can stay in the hive for many months, even during winter. Dead larvae creates strong (if uncapped) or weak (if capped) putrid smell.

In some colonies disease develops gradually. However usually it advances fast, and can kill the colony of bees. All races if bees are susceptible to false foulbrood, but some sources say, that Italian bees are mo resistant than others.

Bee colonies can have several diseases in the same time.

All mentioned above, foulbrood infections are not deadly if treated early without medications. Complete liquidation of these diseases can be achieved by technological reproduction regulation. Infected colonies become broodless in 21 days after queen isolation.

Causative agents stay on wax and other parts of beehive, which have to be disinfected. To do that, bees have to be transferred to a clean beehive with disinfected comb for 22 days. In warm weather replace infected beehive with a clean one. Piece of cardboard should be placed in front of the entrance. Move the sick colony between half and one meter away, open the hive and shake the bees form the comb in front of new beehive entrance. Bees and queen will enter clean beehive. The next day check the middle frame. Take it away if it has some infected honey in it. Queen has to be replaced. Artificial foundation can be used if nectar flow is high. Combs with honey and bee bread from infected beehive have to be taken away and never used to feed other colonies. However, honey from the infected hive is not harmful to people.

Thus, it is possible to treat foulbrood without medication. Same methods can be used to treat chalkbrood. We should remember that there is a constant threat of infections appearance in the nest. Therefore, only strong colonies should be left in the bee yard. They will be able to create good living conditions for larvae (stable temperature and good nutrition), which will help it not to get sick even after contact with infection. Mixed infections, combining some or all mentioned brood diseases will be successfully managed if the Queen Isolating Cage is used properly.

# Proper ways to disinfect against foulbrood

Beehives, frames and other wooden parts of beehive must be thoroughly cleaned and fired with blowtorch until they turn brown. A 10% solution of hydrogen peroxide and 3% of formic (or acetic) acid is then applied, using 1 liter per 1 square meter of surface. This treatment must be repeated every hour for 3 hours. A warm (30-40°С) alkaline solution may also be used: 5% of formaldehyde and 5% of caustic soda (0.5 liters per 1 square meter, two times with 1 hour interval). Approximately 5 hours later beehive should be rinsed with water.

Comb disinfection should be performed in a room away from bees. A 5% solution of iodum monochloratum or 3% hydrogen peroxide and 3% of formic (or acetic) acid can be used. Comb can be sprayed till cells are completely full or dipped in the solution for 24 hours. Later it should be rinsed with water and dried. Hydrogen peroxide has no smell, bleaches the comb well and helps the bees to clean it from leftovers of bee bread, feces and wax moth. Solution of iodum monochloratum also helps bees to clean the cells. Same methods can be used to disinfect Queen Isolating Cages.

Old comb which turned black and has some brood in it should be melted down and processed for wax foundation. A method invented by Khmara and Bondarchuk can be used for disinfection. Waste is burned and processed using extraction.

Frames can be disinfected by boiling in 2% solution of caustic soda or 4% solution of caustic soda for 15 minutes.

Honey extractors should be rinsed with hot water and disinfected with 5% of formaldehyde and 5% caustic soda solution. Disinfection lasts for 5 hours (1 liter per square meter). After this, extractors are rinsed with hot water that must be discarded in a way that bees cannot get to it. Chisels, cages for queens, feeders, and other containers for honey, wax melters and presses can be disinfected same way as honey extractors. The beekeeper's working clothes should be boiled for an hour or soaked in 2% solution of formaldehyde or paraformum.

Small tools can be soaked in 3% hydrogen peroxide for 1 hour, boiled in 0.5% solution of caustic soda or 3% soda ash for 30 minutes.

Bee yard territory should be disinfected 5 centimeters deep. A 4% formaldehyde (10 liters per square meter) solution can be applied for 10 days on chernozem soil, and 7 days on podzolic soil. Chloride lime (38% of available chlorine) can also be used by mixing it into the top 5 centimeters of soil (5kg per square meter) and then spray water. In this case treatment lasts for 10 days.

When beehive equipment has been disinfected, worker bees can be transferred. New nests are created depending on the size of the colony, plus 1 or 2 frames of new foundation. Creating bee colonies you should only use disinfected objects, including feeders, screen boards, etc.

# Treating chalkbrood

Chalkbrood appeared not so long ago, and beekeepers fairly consider it the most harmful disorder. It is caused by fungus Ascosphaera apis, which is one of the oldest inhabitants of Earth; it is about 3 billion years old. Bees populate on our planet for about 100 million years, and were coping with chalkbrood before people begin to “help” them. Beekeepers started to use antibiotics, sulfanilamides, and acaricides, which destroyed bees’ immunity. It is believed, that antibiotics became the main reason for the weakening immunity of bees, which is also true for humans. People now have allergies due to antibiotics use.

In my opinion, it is unacceptable to allow antibiotics in honey and other beekeeping products. Having an allergic reaction, people believe that it is caused by honey, not realizing that antibiotics in honey are responsible for this. Chalkbrood affects drone and later worker larvae of 3 and 4 days old, located on the periphery of brood nest. Dead larvae turn into hard mummified pieces that look like chalk or lime. Fungus spores are very resistant and can survive up to 15 years in the environment. They stay alive for a year in a temperature of +27° С. In an empty beehive, spores can live for 4 years on comb and beekeeping tools. Solution of 1% formaldehyde and Glutaric Aldehid kills the spores in 20 minutes, 1% hydrogen peroxide - in 30 minutes, and 3% solution of chloride lime and hypocloride – in 10 minutes.

Brood can be ill with chalkbrood for the whole spring-summer period. Some researchers believe that chalkbrood appeared due to excessive use of antibiotics, unfavorable environmental conditions and lack of bee bread.

Worker bees, drones and queens do not get sick with chalkbrood, but can be infection carriers. Healthy colonies can get it from robber bees, roaming bees and drones, movement of comb, and beekeepers that do not disinfect their hands and tools after working with sick colonies. It can spread through new queens and packages of bees, pollen and protein paste, made of infected pollen.

Fungus spores get into bees’ intestines, and on the body through honey and bee bread. Mycelium develops in midgut first, than extends to other body tissues, killing the larva. Later it covers dead body with while mold. On the rear end of dead larvae it looks like gray cap. These bodies are easily cleaned by workers, fall on the floor, and sometimes accumulate in one corner or in front of beehive. Mold can be noticed on the lower part of combs as well.

Weaker colonies get sick more often after long fall of temperature and increased air humidity. Diagnoses should be based on study of clinical signs, microscopic and micrological investigation of diseased brood, and epizootic data. A sample of comb with dead and sick brood should be sent to the lab of veterinarian medicine (10 by 15 centimeters of comb with frame). A random sample of pollen and bee bread meant for sale should be checked as well (10 grams of each lot). If you are planning to use protein paste, which contains pollen, check its purity by sending 50 grams for research as well.

For microscopy of pathological material you should prepare mycelium from dead larvae, pollen, bee bread, and a drop of glycerin; put it on microscope slide. You would need 7x10 magnifications. Presence of typical cysts, filled with fungus spores, in floccus mycelium can be a basis for preliminary diagnosis. For confirmation you would need to do planting on agar Saburo (meat infusion agar) or other growth mediums. Incubation takes 10 days with a temperature of 26 to 30°С. In case of a positive result, white fluffy colonies would appear between the 3rd and 5th day. They will turn greenish-gray between the 8th and 10th day. In positive cases microscopy shows multicellular mycelium with multinucleate cells, branchy hypha, spores of spheroid cyst. Spores are small, elliptical, smooth, and colorless.

If diagnosis is confirmed, apiary should be placed in quarantine. It is forbidden to remove colonies of bees, queens and beekeeping products from such bee yard. Bees can be moved to other locations for honey production but not closer than 5 to 7 kilometers to a healthy apiary. Sugar syrup should be given to a sick colony separately. Combs with mold must be melted down; colonies should be reduced and well insulated. They need high quality food and good hive ventilation.

Beehives, frames and other wooden objects can be disinfected with a 10% hydrogen peroxide and 0.5% formic acid (apply twice for 4 hours) solution; or a 4% or 10% solution of iodum monochloratum applied for 5 hours. Afterwards all equipment should be rinsed with water and dried. Empty combs need to be sprayed with GLAK for 2.5 hours; or A 10% hydrogen peroxide and 0.5% formic acid (apply for 4 hours); or solution of iodum monochloratum applied for 5 hours. After that combs should be rinsed with water and dried.

To disinfect pollen you would need a mixture, containing 1% thymol, 98.85% acetone, 0.1% boiled water, and 0.05% dimethyl sulfoxide. Mix 1 part of such solution with 2 parts of pollen, put it in hermetic container and leave for 10 days. Drain the liquid afterwards. Pollen should be dried and can be used for feeding bees.

Honey extractors and metal tools are disinfected with the same solutions, and rinsed with water. Honey from diseased colonies can be used for human consumption, but cannot be fed to bees.

Preventive measures against chalkbrood include good insulation for beehives, and hive location in dry places. Size of the nest has to correlate with colony size. There should be no combs without bees. Bees should be supplied with appropriate amount of honey and pollen. Moisture in beehives should be prevented.

Temperature control in the nest (34.5° to 35°С) is a very important factor: warm and well fed larva will not get sick even if infection gets into its body. A strong colony is able to stabilize the temperature constantly. If you split a healthy colony in two, both parts may become ill due to lost temperature stability.

Chalkbrood is not a deadly diagnosis if infected colonies receive timely help without medications. It can be completely liquidated by using reproduction management method (newspaper «Health of animals and medicines» № 9, 2007). Reproduction should stop for 21 days in diseased colonies by isolation of their queen. Due to this there will be no brood in combs.

Causative agent of this disease stays in combs and other parts of beehive, thus they need to be disinfected. Colony should be moved to another beehive with fresh comb. This has to be done on 22nd days after queen isolation. It is best if the weather is warm and bees have nectar to collect. A piece of cardboard (60x70cm) should be placed in front of the entrance. Move the sick colony 0.5 to 1 meter away, open the hive and shake the bees from the comb in front of new beehive entrance. Bees and the queen will enter the clean beehive.

The next day combs in the middle should be checked. All honey stored by this time should be taken away; the queen has to be replaced too. Wax foundation can be used if nectar flow is high. Honey obtained from infected colonies should be extracted and disinfected. Some combs have to be melted.

Therefore, colony can be cured from chalkbrood without any drugs. There is always a chance of getting some kind of infection in the beehive. Mixed infection, combining some or all mentioned brood diseases will be successfully managed if Queen Isolating Cage is used properly.

***Treatment of sacbrood***

Treatment is done same was as for foulbrood, but equipment disinfection has some differences. Beehives, boards and frames go through mechanical cleaning first, and then should be disinfected by one of these solutions (0.5 liters per square meter each): 4% hydrogen peroxide; 5% nirtan, and 1% formaldehyde, applied for 3 hours. Combs are disinfected with hydrogen peroxide and formalin in same concentration. Wax should be decontaminated using methods invented by Khmara and Bondarchuk.

# Sanitation against adult bee illnesses

***Tracheal mites***

All races of bees are susceptible to tracheal mites; thought Italian bees show somewhat higher resistance. Acarapis woodi is a mite that damages trachea of worker bees, queens and drones. Mites have sucking mouthparts, which helps them to feed on bees’ hemolymph. The development cycle is between 11 and 13 days for a male and 14 to 16 days for female mites. Usually 2 or 3 times more females are born. Female mites, which emerge in bee’s trachea get out and stay on hairs to be able to move to another insect. More than 150 mites can parasitize on one bee. In winter, mated female mites can live at the base of bee’s wings. Mites cannot live outside bees’ body long: in dead bees they can live for 5 to 12 days, 2 to 3 days in water and 10 to 12 days in vaseline.

Only adult insects can get tracheal mites. No such parasites have been found on larvae and pupa of honey bees. Usually disease develops slowly, depending on living conditions, colony strength, and number of mites.

Disease is stimulated by high humidity, proximity of rivers, lakes and swamps. Cool weather slows bees down, which promoted tracheal mites reproduction. Mites enter through stigma to the first pair of trachea of bee. Acarapis woodi causes three main damages to bee’s health: it feeds off its hemolymph, pokes the wall of trachea that causes loss of protein compounds and produces toxic substances; interchange of gases is disturbed due to pathological changes in trachea and their occlusion by mites is deadly to the bee; wounds can bring hazardous microflora to bee’s body that can cause infectious disease and weaken immunity.

Clear symptoms of this disorder appear in the end of winter and early spring, when 30 to 50% of bees in the colony are damaged. Diseased colonies are disturbed, cluster is not compact, and bees with enlarged abdomen exit the beehive and die. Stains of feces can be seen on combs and walls of beehive. The main symptom for tracheal mites’ presence is disturbed flying, and appearance of crawling bees with asymmetric wings in front of beehive in early spring. Bees usually die in winter and spring. Brown or black stains can be seen on tracheas of dead bees. Sometimes tracheal mites’ disorder is accompanied with nosema and foulbrood, which makes diagnostics more complex.

For proper diagnostics Acarapis woodi mites must be found in bees’ trachea. This will require a special research in a veterinary lab. Clinical signs are important, when typical changes in trachea took place. Nosema and foulbrood have to be differentiated.

# Treating tracheal mites

The queen in an infected colony should be isolated for 9 days. Frames with capped brood are moved then to another beehive. It is best to have at least 4 such frames in each nest. To kill mites on comb and other parts of beehive, they are treated with acaricides. The beehive is then well insulated and receives a new queen. It should be located on a new spot. It is important to stop robbing by other bees, roaming and attacks. Entrance is closed for 6-7 days. The colony should stay under supervision. Relapse is possible if mites will be brought from other colony. All treatment techniques are taking into consideration the fact that only adult bees can get sick. There is no Acarapis woodi in brood, thus just emerged bee is always healthy. There are no mites in its trachea. Thus, adult bees with parasites should be separated from the brood. Open brood requires optimal microclimate conditions, therefore reproduction should be stopped to obtain only capped brood (10th day). This brood does not require feeding; it only needs certain microclimate conditions. Separating mature bees from brood enables us to prevent mites from getting to young bees. Mites cannot survive outside bee’s body, but to be absolutely sure, an acaricide needs to be applied on brood surface, frames and other parts of beehive. Folbexum can be used for this purpose.

So, at first, capped brood is separated from worker bees. Young emerging bees will be creating proper microclimate in the new colony. The queen should be introduced to the colony the same day it is separated. Queen should have no infectious diseases and come from a good colony. Heat insulation should be very reliable to ensure proper incubation of brood without worker bees. Such manipulations should take place only in warm weather (25 °С to 35°С).

To ensure successful treatment against tracheal mites, healthy colonies are moved away while their entrances are still closed. The distance can vary, but it must ensure that bees with parasites do not contact with the healthy ones. If old colonies can produce more capped brood, you should let them do that. Otherwise, they need to be destroyed. This will help release a whole apiary from tracheal mites without medication. Only equipment is treated with acaricides.

# Bees’ septicemia

 Septicemia is a deadly infectious disease. Sick bees fall apart when handled. Pseudomonas aeruginosa is the bacterium that causes septicemia. It is very resistant to physical influences. It stays viable in dead bees for a month if away from sunlight. A 3% or 1% solution of hydrogen peroxide and 0.5% solution of formic acid kill this bacterium in two hours.

This bacterium is widely spread in nature. It enters the body through respiratory organs. A bee's body becomes more susceptible if tissues are damaged by tracheal mites, varroa mites, flies larva, bugs, etc. Poor living conditions (high humidity, liquid uncapped honey, cold and rainy weather) and insufficient nutrition promote development of this disease. Most often bees get sick in spring and summer.

Septicemia usually has no notable symptoms. Sick bees are weakened and unable to fly due to damaged pectoral muscles. They die in few hours in convulsion, with spasmodic abdomens and shaking legs. Instead of being light brown, hemolymph turns white due to the bacteria in it.

Dead bees fall apart (detached head, antennae, abdomen, wings, legs and hairs). One of the symptoms of septicemia is liquid feces, which pollute combs, beehive walls and entrance boards. If a colony is infected with two diseases simultaneously (septicemia-varroa or septicemia-nosema), it will die faster.

Preliminary diagnoses can be made based on clinical signs, but a lab examination is needed to verify it. It might require a bioprobe. Septicemia can be diagnosed if material shows signs of Pseudomonas aeruginosa.

 Curing this disorder also requires queen isolation (like in the case with tracheal mites). The only difference is: capped brood and frames need to be disinfected with a solution of tetracycline or chlor-tetracycline (300 thousands units per 1 liter of water). Beehives and tools are cleaned by 3% water solution of hydrogen peroxide (1%) and 0.5% of formic acid. The same solution can be used to disinfect comb, which later should be rinsed and dried. Wax should be processed using the method offered by Khmara and Bondarcuk.

# Chronic Bee Paralysis

Chronic bee paralysis is a common viral disorder that affects adult and developing honey bees. It can occur in one colony, a bee yard, or several apiaries at the same time. It can kill bees in any time of the year, but most often in summer. Abrupt weather changes or lack of bee bread can cause this disease outbreak. Inside the colony chronic paralysis spreads through feeding contacts, and drones can take it to another colony. The more RNA virus has enters a bee’s body, the faster pathologies develop. The virus propagates in cytoplasm of nerve tissue cells in small intestine, mandibular and hypopharyngeal glands of adult bees. Chronic bee paralysis is often found in conjunction with acute paralysis. At the temperature of 30°С, symptoms of acute paralysis appear first, and at 35°С, chronic paralysis is observed earlier.

 Symptoms may show up between the 4 and 10th day after infection. Sick bees in large numbers are found crawling at the hive bottom. They do not eat, shiver and cannot fly. Later they get limb paralysis and die in 11 to 20 days. Appearance of dark hairless spots is another typical symptom. Bees look shiny, have small abdomens and start looking similar to ants. However, these signs are not always present. Healthy bees bite off hairs of infected bees, explaining the shiny hairless appearance. Diseased insects also have metabolic disorders. Sometimes we can see revolving and abnormally moving bees in front of the hive entrance.

Diagnostics includes analysis of clinical signs and lab study. If Morrison corpuscles are found in cytoplasm of mucous membrane in small intestine, the disease is confirmed

To prevent this disorder, the bees must not be overheated and they must be supplied with appropriate amount of bee bread. Sometimes it is recommended to use endonuclease and ribonuclease. The reproduction regulation method should be used to normalize metabolism of bees. To do that, the queen is isolated for 10 days. If this does not help to slow down diseases, the capped brood should be removed and bees moved to a new hive (similar to the treatment for tracheal mites). Combs with capped brood are placed to such beehive; the entrance is closed with a net. A queen from a healthy colony is given to the new one. Open the entrance on the 4th or 5th day. The colony should be protected from theft and attacks by other bees.

While the entrance is closed, feed the bees with sugar syrup (1:1 ratio). In the diseased colony the queen is released when all brood is removed. The colony usually shows no symptoms after one day. Weakened broodless colonies can be combined. Do not hurry. Bees that were forced to produce royal jelly will be released from this exhausting obligation. The colony will show signs of recovery when young bees that do not have to feed the brood, emerge. This will take place on the 35th to 37th day after queen isolation. When the colony recovers, the queen can be released from the isolation cage (open the special entrance for her). It is important to get rid of nosema if it is present.

# Acute Paralysis

Acute paralysis of adult bees is caused by RNA virus. This virus is resistant to heating and transmitted by female varroa mites. It propagates in nerve tissue, cells of pharyngeal glands and fat of adult bees. This virus has been discovered in a form of inclusion in mucous membrane of midgut. Small numbers of the causative agent is sometimes found in healthy bees.

Viruses of chronic and acute paralysis develop fast after entering a bee’s body. This does not happen though, if the bee carries agents of sacbrood or Morbus сеllа matricis nigra. An acute paralysis is hard to diagnose in autumn period. The clinical course depends on the colony’s resistance. The acute form usually develops in unfavorable living conditions, and as an aftereffect of other disorders such as nosema, varroa, etc. In the colony, the virus spreads through feeding contacts or by varroa mites. Most often it is noted in the end of winter, spring, and summer. Young bees are more susceptible, possibly because they are feeding larvae with royal jelly. Ill bees lose their ability to fly, crawl and jump in front of beehive, and crowd near the entrance. Some bees have an abnormally large abdomen and dislocated wings. This is usually notable in the morning. Dead bees can also be seen on the floor. Damage caused by paralysis varies from several bees to colony or a total apiary collapse. This disorder can last from 7 or 8 days to three months.

Acute paralysis is often diagnosed in conjunction with chronic paralysis, nosema disease, filamentovirosis, and varroa mites.

Prevention should start with treating nosema if it is present. Sanitary rules have to be followed to increase bees’ resistance. To do this, nursing bees must stop producing royal jelly, thus reproduction regulation must take place (just like in case of chronic paralysis). Bees can be cured in 10 days after queen isolation. In this case capped brood can stay in the colony, which is supplied with sufficient amount of high quality food.

# Tropilaelaps Clareae

This is an invasive disorder that is caused by the Tropilaelaps clareae mite. The female mite is elongated; it has reddish-brown color. Its size is approximately 1 millimeter by 0.5 millimeter, while the male is smaller, at 0.88 by 0.51mm. This mite breeds in capped cells of drone or worker brood, and sometimes in queen cells. Its development cycle is 8 or 9 days. Mature female mites can gnaw through cappings and get out of cell. They can live only 1 or2 days on adult bees, though. This means that the Tropilaelaps clareae mite cannot survive in a broodless colony. Therefore they cannot survive winter. But, they can constantly parasitize colonies of bees when they have brood.

**Symptoms.** Tropilaelaps clareae most often appears in hot weather, when bees pupate. As a result, nonviable bees and drones emerge. Brood is reduced and can disappear completely in infected colony. Undeveloped and distorted bees and pupa can be found on the floor or in front of beehive entrance. The clinical course becomes especially serious when colony has tropilaelaps clareae and varroa mites simultaneously.

**Treatment methods.** Applying the reproduction regulation method against varroa mites, will kill tropilaelaps clareae as well. If you keep an apiary in a climate where brood is present year round, a queen isolating cage should be used to force a broodless period.

# Hafniosis

(paratyphoid, infectious diarrhea)

This is an infectious disease that affects intestines of adult bees and causes diarrhea, weakening and death. It is caused by Enterobacter Hafnia alvei. This bacillus is resistant to temperature and chemical actions, and can survive in an apiary up to 270 days (300 in bee bread), and 70 to 90 days in honey at room temperature. The agent dies in three hours if placed in 0.1 % caustic soda solution at 18 to 20°С; 3 to 5 % phenol and formalin kill it in 1 to 5 minutes. Hafniosis usually appears at the end of winter and in spring if bees consume honeydew or sour honey.

This infection can also get into bees digestion system through polluted water, honey and bee bread. It develops fast and produces a lot of toxins.

**Symptoms.** Worker bees get sick more often. They get noisy, crawl out of beehive, have enlarged abdomen. They cannot fly and sometimes have legs and wings paralysis. This can take place in February and March.

Diagnostics has to be based on clinical signs and bacteriological test. Hafniosis has to be differentiated from salmonellosis, septicemia, honeydew and chemical toxicosis.

Honey obtained from a diseased colony can be sold 3 months later. Wax must be disinfected using methods developed by Khmara and Bondarchuk. The best way to treat hafniosis is to apply reproduction regulation. The queen is caged in warm weather. In ten days they will have only capped brood, which is transferred to a clean beehive, sprayed with water solution of chloramphenicol and neomycin (200 thousands units and 0.2 grams per 1 liter of water). On the second day the new colony should receive a new queen and 1 to 2 glasses of sugar syrup. If the weather is chilly, the entrance should be closed, and beehive moved to a warm room (25°С). On the 6 or 7th day, the entrance can be opened and beehive placed outside. The colony should be protected from robber bees, and preferably 3 to 5 kilometers away from infected colonies. To disinfect hives, frames, and boards should be cleaned in a 3% solution of formaldehyde or 3% caustic soda. Dirty comb should be melted down. Comb that can be reused should be disinfected by 1% solution of iodum monochloratum (3 hours exposing) or 2% formaldehyde for 4 hours.

# Salmonellosis

This disorder usually affects adult bees. It is caused by several species of salmonella bacteria. It is more common if apiary is close to livestock business, polluted lakes and swamps, and when bees are kept in insanitary conditions and lack of quality food and water. These bacteria are relatively resistant to environmental causes. The main sources of infection are domestic animals and wild birds.

**Symptoms.** Bees usually get sick during the end of winter when kept in insanitary conditions. The bees' intestines become damaged and they suffer from diarrhea. During early flights in spring they produce sticky, liquid, yellow-brown feces with bad smell.

**Treatment.** Salmonellosis is treated same way as hafniosis, using the reproduction regulation technique.

# Colibacillosis

 This is also adult bees’ disorder which causes them to die from intestine disease. Varroa mites spread colibacillosis and weaken bees’ bodies.

The causative agent is Escherichia coli, colibacillus. Infected bees spread it to others. Usually colonies show signs of this disease in the end of winter or beginning of spring.

**Symptoms.** Bees are anxious, they exit the beehive. Spring flying is disunited; sick bees are passive, have enlarged abdomen and can’t fly. Combs and beehive walls are soiled with excrement.

**Treatment and prophylactics** measures are same as for hafniosis and salmonellosis. Health-improving activities have to be timely and integrated. It is important to prevent colony infection by contaminated food. Managing the number of varroa mites also helps.

# Aspergillosis

Aspergillosis is also called “stone brood” or aspergillomycosis, because it is caused by mold fungi of several varieties. All bee races and their brood are susceptible to these pathogens. They look like felted cloth, raising 0.5-0.7mm above the surface of their food solution. It consists of floccus with nodes on the ends.

Aspergillus flavus (the most pathogenic) is most common; Aspergillus niger and Aspergillus fumigatus are rare.

Fungi are saprophytes that live off organic waste, pollen and nectar. They are resistant to chemical and physical factors. Therefore it is impossible to kill them completely.

Aspergillus fungi die in 30 minutes when temperature reaches +60°С. They are also quickly destroyed if treated with 2-3% phenol, 5% formalin, 4% iodum monochloratum, or a combination of 10% hydrogen peroxide and 0.5% formic acid.

If this fungus in sugar syrup is consumed by the bees, the bees will die in 2 to 4 days. However, larvae rarely get infected this way. It must have some special immunity, which is not typical for adult bees.

Aspergillus fungi are prevalent in nature, live and develop in favorable conditions in soil, humus, decaying and growing plants, stamens, pistils, and nectarines of flowers. Disease can appear in high humidity, rainy weather, humid hives located in lowland or shady places near water or swamp, when beehive is standing on the ground or too low.

Some colonies can become infected in spring time. Weaker colonies are more likely to have this disorder. This can be explained by lower temperature, which causes larvae to chill and therefore makes them less resistant.

Spores are delivered to the beehive by worker bees along with nectar and pollen. They grow especially well in high humidity on bee bread, on combs, larvae and pupa, adult bees. Pathogen gets into intestines when nectar, honey, pollen or bee bread is consumed. Sometimes bees get infected through damaged investment. Aspergillus flavus and fumigatus emit toxins, causing toxicomycosis. Larvae and bees of different ages can get sick. They die in 2-4 days after being infected. The disease can have an explicit or hidden form. The explicit form causes brood and sometimes adult bees to die. Larvae and pupa get covered with white or grey mold, shrink and lose body segmentation. Later they become hard and turn yellow-green or black, depending on fungus variety: yellow-green when it is Aspergillus flavus or fumigates, and black if Aspergillus niger. Mummified larvae become hard and dark, look like stones, and are easily removed from the cells. Adult bees infected with fungi are excited, move actively, then get weaker, fall on the floor and die. Dead bees are covered with dark-green mold and their abdomen becomes hard. In high humidity, the fungus starts growing on the bee’s body and produces spores. For lab tests, a brood sample (10 by 15cm) and at least 50 dead bees should be sent for examination in a sterile sealed container. You can easily find them on the beehive floor right under the brood nest. As the colony gets weaker, it becomes unable to remove all dead bees, and they get build up on the bottom board.

**Diagnosis** is based on clinical signs, epizootological data and results of microscopic and mycologic analysis. In the lab, dead bees are placed in bacteriological dishes and studied under a microscope with light magnification to see fungus with typical conidium-heads with spores. After this they are removed from larvae and bees bodies. A drop of solution (even parts of water, alcohol and glycerin or 50% glycerin) is added on microscope slide and studied with high magnification (7 by 40 or 10 by 40).

For culture separation pieces of dead bodies are placed in a special medium and cultivated under temperature of 25 to 30°С. In 3 to 4 days, if results are positive, yellow-green colonies of Aspergillus flavus start growing; dark-green if it is Aspergillus fumigates, and brown - if you work with Aspergillus niger. They should be differentiated from Ascosphaera apis.

Aspergillosis is considered diagnosed if typical changes in bees and brood are observed or when microscopic research shows presence of causative agents in pathological material, even though bees and larvae have no symptoms.

If an apiary has shown aspergillosis presence, restrictions and start sanitary actions should be implemented. It is strongly advised not to move colonies of bees, queens, bee packages, and beekeeping products to other apiaries. Infected colonies can be moved for honey production, but not closer than 5 to 7 kilometers to other bee yards.

It is strongly advised not to use honey and bee bread from infected colonies. After mechanical cleaning, beehives and beekeeping tools should be fired with blowtorch or treated with 5% formaldehyde. Soil around beehives should be dug over and sprayed with 4-5% formaldehyde solution (10 liters per square meter).

Beekeepers need to be careful not to breathe or touch fungus spores. Thus, while working with diseased colonies, beekeepers should wear protecting clothing, gauze bandage, and handle pathological material with care. When work is done, hands should be thoroughly washed and mouth rinsed.

A bee yard is considered free from aspergillosis in one month after disease liquidation and disinfection.

Health improvement of bees is based on artificial reproduction regulation. The main purpose is to get clinically healthy bees in the period when there is no brood in the colony. To do that, the queen is caged for 21 days to allow the colony to become free of brood (the main residence of most infections). This will allow the number of causative agents of diseases to be minimized. If drone brood is present, the period should be extended by 3 days. The decline in pathogen numbers is explained by the fact that young bees, which that emerged during broodless period, did not have to feed larvae with royal jelly and therefore are more resistant to infections. Six days after queen isolation there is no need for worker bees to produce royal jelly, and in 3 more days all brood is capped. ***In other words, bees become physiologically young and resistant to infection.***

A colony that has been prepared in this way should be transferred to a disinfected beehive. It should receive a new queen from a healthy colony. Two days later you should take away comb with honey, since it may be contaminated, and replace it with fresh ones. When colony has access to pollen and nectar, it can be given 1 or 1.5 liters of sugar syrup (1:1.5 water:sugar ratio). If there is no nectar flow, it should be substituted with sugar syrup. If there is a shortage of pollen, bee bread from a healthy colony can be provided to the bees. During the next month the condition of such colony should watched closely, especially its brood. Queen should be isolated if first signs of disease are noted.

**Best prevention against aspergillosis:** keeping only strong colonies. There should be no unused comb in small colonies. Nests should be compact and easy to stabilize temperature. Each colony should have at least 6-8 kilos of honey and sufficient amount of bee bread for good development. Beehives should be located in dry, well lit places with good ventilation. No medicines should be used.

# Spring sanitation procedures

Good spring sanitation becomes possible due to proper use of queen isolating method that guarantees that the colony will have no brood in winter. Presence of brood, on the other hand, can weaken and even kill the colony. In spring time bees begin to fly, which some beekeepers call “bee’s Easter”. Bees from strong colonies start to fly all at once. If that does not happen, it should be watched closely. It might be that the entrance is closed by the pile of dead bees. Other reasons for poor flying in spring could be tracheal mites, hafniosis, salmonellosis, and colibacteriosis, which causes diarrhea. Tracheal mites are usually diagnosed by twisted wings. Bees cannot fly, walk out of beehive and crawl in front of it.

# Nosema disease

Reproduction, stopped in the end of summer, is the best way to treat and prevent nosema disease. Reproduction should be halted before the weather gets cold to lower the amount of pathogens in bee colony. The best period is July 15th. Most often nosema disease appears in the end of winter or beginning of spring, or in other words - at the time when brood appears. This is explained by the fact that brood feeding activities in a winter cluster, weakens the colony greatly. Bees become exhausted and therefore more susceptible to diseases. Lack of brood, on the other hand, creates favorable conditions for bees’ health improvement. Brood requires extra efforts from the bees to be warmed and fed. However, such care is much easier on bees during warm periods. The worst situation is when brood appears when bees cannot leave the cluster. At first sight, these factors can seem insignificant, but they do shorten bees’ life expectancy and make them physiologically older. Therefore there are more opportunities for invasion.

The main problem with brood presence in winter time is the necessity to secrete royal jelly and serving the brood in a limited space (cluster). In this situation bee bread is inaccessible, which means it is replaced by more royal jelly. In such conditions the bees' body gets much weaker, which promotes development of nosema disease. The peritrophic membrane, a protective tissue of midgut, is being destroyed, and causative agents of a disease can get into the blood system and cause sepsis. When the intestine is damaged, other glands and organs cannot function as well. The bees' body fat is reduced, muscles become atrophied, and body mass goes down. Sick queens have ovary degeneration; diseased bees usually get diarrhea, thus spreading the disease in the cluster.

At the same time we can see non-contagious diseases developing. This is also a result of unhealthy circumstances in a cluster of bees.

Sometimes in winter, if weather gets warmer for some time, queens are motivated to lay eggs. If brood appears, the process usually lasts until spring. Such colonies age quickly due to fast aging of individual bees. On the contrary, clusters without brood are more likely to remain healthy and have a good performance during first flying in spring. Usually these colonies in 3 or 4 weeks outperform those that started reproducing in winter. This can be ensured by applying reproduction regulation methods, avoiding such diseases as nosema and other pathologies in bee colony. Thus, one of the main factors for bees’ health is queen isolation from 15th of July until spring nectar flow starts. ***The queen should be released if pollen is observed on bees’ legs.***

A queen hat is not isolated can get nosema disease. It is hard to diagnose because other diseases also cause diarrhea. This disorder is a result of poor quality food and lack of ventilation in beehive during winter. It is unlikely to hurt a colony with an isolated queen, good food, ventilation, and compact cluster. Queen isolation is the best prophylactic measure against nosema disease. **The queen must spend the winter in an isolation cage!**

Worker bees, queens and drones can get nosema. It is caused by nosema apis - intracellular parasite, which lives in the environment in a form of spores. This parasite develops in bee’s body in a temperature of 22° to 34°С (optimal 31 to 32СС) and cannot grow when temperature falls below 22°С or higher than 34°С. These spores are very resistant to environmental causes, but die under sunlight in 15 to32 hours. Some bees are more resistant to nosema than others. Bees that emerged in early spring are more susceptible than the autumn ones, primarily because of the physiological youth of the bees that emerged in fall. They did not have to feed the brood, and therefore are more resistant to nosema disease.

Nosema usually takes place in the end of winter and can cause colony partial or complete die-out. The sources for nosema invasion can be dead or ill bees and their feces. Nosema disease can also be caused by honey, polluted with honeydew, abrupt weather changes, high humidity in the hive, disturbance, long winter, feeding sugar syrup in large quantities in fall, lack of bee bread, rainy cold weather, or food contaminated with pesticides.

The best conditions to prevent nosema include maintaining physiologically young, long living bees that spend winter in optimal microclimate conditions and consume high quality food.

On the contrary, nosema spreads by roaming and robbing bees, drones, movement of combs from one colony to another, use of infected tools and equipment, joining two colonies together, purchase of infected queens, etc.

Nosema is common in all continents that have honey bees. It occurs most often during the spring and summer. The main symptom for the typical form of nosema disease is diarrhea. A hidden form is considered conditionally-pathogenic, because it develops only in weakened body.

Sick bees usually seem disturbed and noisy. The front of the beehive is usually dirty with feces. Colonies die or become weak. Flying is inactive and infected bees are crawling in front of beehive. This colony cannot rear brood. Bees stop actively collecting nectar and pollen. Sick colonies develop poorly in spring; brood size goes down by 4 - 8 times and supersedure often occurs. Young queens are undeveloped and deficient; bees are reluctant to receive them and try to replace such queens every 2 to6 weeks. Sick bees have enlarged abdomens, shaking wings, fall down and die. Nosema is often accompanied by other diseases, such as amebiasis, hafniosis, chalkbrood, aspergillosis, tracheal mites, etc. If a colony is strong enough and receives timely treatment, it will recover by the middle of summer and can produce some honey. If a colony was damaged badly, it should be reinforced by adding extra brood and young bees or combined with another colony.

**Diagnoses** should be based on research of clinical signs, microscopic analyses, and epizootic data. Approximately 50 dead bees and feces from combs and beehive walls should be sent to the laboratory. Sometimes, it is necessary to send 100 grams of honey and 12 grams of bee bread in glass jar as well. The same research should be done in July or August to check the results of treatment procedures. The quality and presence of honeydew in honey that is meant for winter should be checked.

If nosema disease has been discovered, movement of hives from the apiary is restricted. Beehives are moved outside early, their floor should be cleaned and dirty combs replaced with clean ones filled with high quality food.

In spring the bees should be moved to disinfected beehives with compact and well insulated nests. Combs with brood can be moved to the new beehive after cleaning frames. Weaker colonies can be joined together, using a plywood split board. Nests cannot be chilled and bees should not be fed honey from infected colonies. Try to support breeding and replace queens if needed.

**Treatment** usually takes place in first week that bees begin to fly. Fumaginine, sulfadimine, or nosematol can be used. If you have applied any of these medications, honey is considered contaminated and cannot be used for consumption.

***In order to produce pure, high quality honey that can be exported or sold within the country, beekeepers should treat bees without medication.*** To do that, the queen needs to be isolated for 9 days. After this period the colony will have only capped brood. Twelve days later all young bees will have emerged. Such brood without bees should be placed between two colonies. Thin separating boards and good insulation need to be used. The entrance for a new colony should be located on the opposite side of the beehive. It should be closed at first to prevent robber bee damage and brood damage. Empty combs need to be filled with sugar syrup (1part water to 1.5 parts sugar). The queen should be placed in a nucleus colony on the 2nd or 3rd day. Sugar syrup and honey from healthy colonies can be fed to this colony. Thus, the main idea for this health improving method is obtaining completely capped brood, since it does not require care of adult bees.

A nucleus colony can be warmed by other two colonies, thermostat, or in a warm room (+25 - +34°С). It is important to maintain a proper temperature for incubation. In cooler temperatures, incubation can take longer than 13 days. Higher than +35° С temperature is also not good because bees that emerged earlier than 12 days will be underdeveloped. If the nosema problem is minor in a colony, you can postpone treating them until the weather warms up, heating problem disappears, and brood can be incubated in a separate beehive. Beehives, boards, and feeders have to be disinfected by 2% alkali or soda ash after they were cleaned of feces, wax and propolis. Wooden equipment should be rinsed with water, dried, and fired with a blowtorch. Old combs have to be melted down or disinfected with 4% formalin with 4 hours exposure. They can be wetted on both sides or treated with 80% acetic acid or essence (200ml per 12 frame beehive). It should be exposed for 4 days with +16°С temperature. Formalin steam can be obtained in a metal container with a tube. Pour 100ml of formalin and 300ml of water in it, heat until steam is created. Steam is then directed to enclosed beehive with combs. Treatment should go on for 30 minutes. Small metal tolls can be boiled in 3% solution of soda ash. Large apiaries usually use gaseous substances (propylene oxide with methyl bromide). An apiary can be considered free from nosema disease if bees have no more clinical signs after final disinfection.

# Reproduction management - basis of beekeeping technology

Reproduction regulation is recommended to improve labor productivity and efficiency in beekeeping. This method can be applied along with specific beekeeping methods.

# Managing swarming

Swarming is a process that stipulates life and survival of bees as a species. In this process a bee colony, as a super-organism, is born by another super-organism. The only way to stop this process is to rebuild or exclude certain genes. However, it is possible to manage swarming condition of bee colony. Swarming is a natural event that prepares a bee colony for the appearance of new super-organism. In this period you should use artificial swarming if you need to create a new colony. “Swarming” gene can be realized only in certain conditions. Appearance of “unemployed” bees is one of them. This means that there are fewer larvae than young bees, thus potential of nurse bees is not realized. These bees become swarming ones, and mobilize a colony for swarming. Cramped space and increased temperature support this condition. It is usually stimulated by low nectar flow due to rainy or cold weather. In these conditions bees prepare the queen for a flight: they feed her with less royal jelly, and later stop feeding her at all. As a result, queen lays fewer eggs, becomes lighter and therefore able to fly. Bees start many queen cells on the periphery of comb (most likely comb with brood). During swarming, bees stop working even if nectar flow is present (however, sometimes a good nectar flow can stop swarming process). At this time you should check the colony’s weight. Appearance of queen cells is a final stage for swarming. Natural swarming is often disadvantageous, because it does not allow maximum use of a nectar flow. Swarms exit at undesirable times and you have difficulties with catching the swarm, its settlement, etc. It is difficult to prevent swarming. However, reproduction regulation offers you an opportunity to manage swarming process. Usually during swarming bees of different ages and queen are leaving the hive, settle on the tree, and look for a new nest. The old colony usually has several queen cells left. If beekeeper does not interfere with this process, a few more swarms may leave the nest when new queens emerge. When one queen is left, the colony stops swarming. The main factors that promote swarming are: nest overpopulation and unemployment of young nurse bees, which usually gather in the remote part of the beehive. Lack of work for adult foragers due to low nectar flow and long unfavorable weather also stimulates swarming (hot and crowded beehive). Naturally, every colony has its own way to react to such conditions – some get to swarming faster, others – slower.

There are many causes for the swarming phenomenon. No one have explained it in full yet.

Gartvig noted excess number of nurse bees that produce too much royal jelly. However, this hypothesis was not proved. The main idea, that all bees become nursing is not correct. In most cases young bees start to collect nectar if there is no brood to feed.

Denuts (1921-1931) suggested that colony starts swarming due to nest overcrowded with brood and bees. However, beehives are not always cramped when swarming takes place.

Butler (1954) supposed that swarming takes place when royal jelly is in deficit. However, swarming usually stops if queen cells are cut off. Also, it is hard to explain why swarming stops in strong nectar flow. It is also interesting, that swarming can be stopped by trading places for swarming and peaceful colony (adult bees interchange). This can be easily done when bees are busy with collecting nectar.

***Artificial regulation of reproduction enables you to manage swarming process.*** You can use this method in different ways, but the main idea is the same. To manage swarming you need to study possibilities of reproduction regulation and understand how to use them in your production technology. It has to be used before swarming season begins. It varies in different regions. Proper application will enable you to profit from swarming. It is especially useful in queen rearing bee yards.

Strong nectar flow is a natural cause that stops swarming. Young “unemployed’ bees start to collect nectar. However, large volumes of collected nectar require more processing activities, such as getting rid of excess moisture. This brings the temperature down by several degrees.

In most cases swarming is an undesirable phenomenon. Thus, it is worthwhile to manage bees work in favorable weather. You can easily spot swarming colony, as it will stop work during good nectar flow. In this situation you should open the hive, and put the queen in isolating cage. If the colony is a good one, you can use it to produce high quality queens. Capped queen cell can be placed in nucleus colony or colony with queen. In this case queen has to be caged (Titov cage). Later these queens can be used to create new colonies or for sale. The last queen cell can be removed on the 8th day of queen isolation. If you want to replace the queen, leave one good queen cell in the colony. If queen is a valuable one – she should stay in isolated until colony starts to work. If the nectar flow is good, queen can be released.

Thus, you know now how to obtain new queens thanks to swarming. Naturally, you can pick most productive colony and artificially create conditions for swarming. To do that you need to add capped brood from other colonies to increase the number of bees. They will soon feel too hot (additional insulation can be used as well). Large number of unemployed bees will soon create “swarming mood”.

Queens, reared in good colonies will be very useful, as the most productive ones.

Scientists, working on selection of “less swarming” bees will argue this technology. But, as we can see, when large numbers of bees is drawn into swarming process, selected bees swarm just like others. Researchers attempting to breed out swarming tendencies were not able to obtain non-swarming bees.

During swarming, bees take as much honey as they can and exit beehive in a hurry. They circle around for a while creating a cloud of bees. Later they typically land on a tree or some other object. If queen is young enough, they will stay there for a short time. Older queen will need more time to rest. After this swarm is flying to a new nest, chosen by the bees.

Beekeepers should not let the swarm to fly away. A swarm is usually gathered in a special box and moved to cooler place. In the evening you can move them to a new beehive with fresh combs filled with food and some frames with foundation. It is desirable to give them a comb with uncapped brood from native colony. Swarm colonies will build comb fast and work well on honey production. Its energy is explained by the large number of young bees that did not have to feed larvae: they were unemployed in preparation for swarming.

Even though swarming is considered inefficient, you can manage it and obtain good queens in this way.

If you want to prevent swarming on the other hand, you should make sure a colony gets sufficient nectar. This can be achieved by moving to a better location. Having nectar to process temperature in beehive goes down due to moisture evaporation.

In summer it is better to locate beehives in shade or cover them with branches or grass, paint them in light colors, turn entrances to the north. It is also important to create good ventilation by enlarged upper and lower entrances. Ventilation openings (45-50 square centimeters) have to be covered with net. They should be closed in winter. If you use Langstroth beehives, you need to open ventilation and add boxes in necessary.

In beehives with closed frames you can use screen instead of floor (2-3mm calls). This can be done for strong colonies in June. There should be enough space between extreme frames and beehive wall to enable bees’ movement to the top of the hive. If you see no robbing, you can open the hive during strong nectar flow. If at this time the colony has a lot of capped brood, you should place empty combs or combs with open brood between capped brood to prevent overheating. Sometimes frames with foundation can be used as well.

It is irrational to keep failing or inferior queens (usually older than 2 years). You should replace at least 80-85% of queens each season. Swarm or supersedure queens are usually the best. Thus, swarming process can be somewhat useful. No one could stop swarming so far.

It is sometimes useful to rear swarm queens while applying the queen isolation cage. Selection for productivity can be done this way too. Only highly productive colonies should be used for queen rearing.

To stop swarming in a colony with several queen cells, the queen is isolated in a cage. Queen cells should be removed. In 6-7 days, remove new queen cells as well. Release the queen when colony starts working again.

Reproduction regulation enables you to manage swarming. When you note first signs of swarming, you should stop reproduction and provide the colony with larger space (add combs). This will work out if nectar flow is present. The better the nectar flow, the faster swarming activities pass.

***Utilisation of strong but brief nectar flows.***

It is useful to stop reproduction 8-9 days before an expected strong nectar flow. This will enable you to use nectar sources more effectively. Bees will be free from rearing brood and all their energy will be used to collect and process nectar. Thus, colony productivity will be increased. Reproduction can be renewed after nectar flow slows down.

***Broodless colonies in a period with no nectar flow.***

It is also useful to stop reproduction when nectar flow stops. For example, white acacia stopped blooming and no other nectar sources are expected. In this case you should stop reproduction and feed the colony with sugar syrup and bee bread if there is no pollen too. This food should be processed while the colony still has brood. There should be at least 6-7 frames of brood and sufficient amount of honey to prepare for winter. When honey from syrup is processed and capped, you should stop reproduction. If there is lack of protein food, it can be substituted by soybean flour, milk, etc. substitutes though are worse than pollen or bee bread. Bees that emerge in this period will be able to survive until spring and perform their traditional tasks in winter.

***Reproduction termination at the end of summer when the nectar flow is declining.***

Honey stocks from nectar and sugar should be prepared while bees have access to protein food sources. You should stop reproduction by placing queen in isolating cage when honey from sugar syrup is capped.

Preparation for winter should not be delayed. At the period when nights are getting longer and colder (beginning of August in northern Ukraine) you should feed bees with a lot of sugar syrup to store 3-3.5 kilos of honey per comb (standard frame 435 by 300mm). It is desirable that most of this honey would come from nectar though. Reproduction should be stopped then. Queen is supposed to spend winter in the isolating cage and be released in the end of March (when bees started to bring pollen). This way the colony will not have early brood. Dates for queen isolation can vary depending on the region. Queen isolating cage should be placed in the middle of the nest. Combs, not covered with bees, should be taken away. This is easier done in temperature close to +7° С.

***Wintering without fall, winter and spring brood***

In regions, close to 50° of northern latitude (including Kiev region) it is reasonable to stop reproduction on 1-15th of July (make adjustments depending on your climatic situation). The best time for all regions is right after big nectar flow. Queen isolation should concur with completing preparation of winter food stocks.

***So-called build-up of colonies strength in fall contradicts to its name.*** The fact is, the later you isolate queen the more life resources will be wasted by the bees on rearing brood. This causes colony to get weaker. On the contrary, if reproduction is stopped at the proper time, colony will get long-living bees. These bees will go through winter well if they have access to high quality food; temperature and humidity in the nest (cluster) should be stable. Varroa mites in this situation will not be able to survive winter. An isolated queen means there will be no brood in warmer winter periods!

***Reproduciton termination in summer due to lack of nectar.***

Reproduction can be stopped for a certain period while waiting for next nectar flow. The colony will be released from extra work and food waste on brood rearing. The advantage of such a strategy is that no short-living bees are born. Only ***long-living*** bees stay for winter. If you do not expect big nectar flow in the end of July or beginning of August, you should make colony broodless and let it prepare for winter.

***Better utilization of main nectar flow.***

Queen should be isolated 10 days before strong nectar flow. In this case, large amount of nectar in the colony will not coincide with presence of open brood, which requires care and food. All attention of bees will be concentrated on nectar gathering. This will greatly increase their productivity. The better nectar flow, the more productive colony will be. Sometimes you can reach several times higher productivity.

If you are planning to move bees long distances, you should isolate queen as well, to save her from possible injuries.

***I hope that queen isolating cage will be useful in every apiary. It can be reused, so you will only need one cage per colony. Its purpose is to prevent diseases, improve bee health and solve other beekeeping problems.***

# Artificial regulation of bees’ reproduction

In a bee colony that consists of thousands of bees, one mature female bee performs reproduction function. It is queen bee.

Worker bees are also female, but they do not reproduce. They can lay limited number of eggs when queen is absent. Queen pheromone affects all worker bees; it inhibits them from developing eggs. Without this pheromone, workers can lay unfertilized (haploid) eggs, which can develop into drones only. A colony that does not have a queen for a long time will eventually die.

Bees lick off pheromone, emitted by the queen, and pass it to other members of the colony. It inhibits them from developing ovaries, and discourages them from starting queen cells. When part of the colony feels lack of mentioned pheromone, they start supersedure queen cells. This way colonies replace queens themselves. New queens emerge without any trouble to beekeeper. It is a favorable situation, and you should not destroy supersedure queen cells. When you see them, you can take excess ones and give them to a queen-less colony or one with failing queen.

All processes in a bee colony slow down during the cold period, fewer resources are used, and therefore lifespan is extended. This condition is influenced by location, weather, winds, humidity, food quality, ability to hold cluster, and possibilities to move in wax constructions. Wild bees build their comb so that it is easy to get to the periphery and back to the center. In a beehive with frames, their movement is limited to vertical. Ability to move horizontally through the nest should be created by beekeeper. This is done by poking holes in the center of the comb. This enables bees to form a cluster and change its shape and location depending on their needs. Temporary ceasing of reproduction in unfavorable conditions is a natural phenomenon, which is important for development of beekeeping and treatment of diseases.

A bee colony stops reproduction to survive during difficult times. In the wild, bees usually protect their stock of honey. It is most commonly stored in the upper part of the nest. Brood is lower than the honey, and its size is reduced during good nectar flows. When the weather gets cooler, there is no warm place for queen to lay eggs. Thus, reproduction stops, bees do not feed brood at the end of summer and the beginning of fall. This way only physiologically young bees stay in a colony for winter.

***Traditional technology is the opposite in this sense.*** Beekeepers extract stored honey. The queen's work is limited only by the size of the nest. If a nectar flow is still present, brood size will be substantial: storing food for winter using sugar syrup speeds up reproduction even more. Slowing down reproduction takes too long and the weather gets very cold. Bees that emerged in this period are usually weaker; they have less protein, and therefore are physiologically older. These generations are unprofitable, hard to raise, and lacking vitality.

A nаtural ability to regulate reproduction is inherent to bees. They prove this when they stop reproduction in fall, during swarming, lack of food, and cooling off. Bees in colder regions usually are physiologically younger than the ones in the south. They can survive lower temperatures and can stay broodless longer. Experienced beekeepers have noted that colonies without brood feel better in winter than those that had brood in fall. Considering all the factors, early reproduction regulation is very advantageous to the bees: food stocks are used more efficiently, there is less die off, and colonies are more productive in spring.

Temporary and timely artificial reproduction regulation enables us to obtain physiologically young bee colony, which consists of long-living bees. The queen has no contact with combs, but receives all necessary care from the bees.

Adult bees that grew up in a colony with brood are short-living and physiologically old. On the other hand, bees that did not feed brood stay physiologically young. ***Intensive work of glands, generating royal jelly uses up protein compounds of bee’s body and causes it to die when the protein deficit becomes critical. At*** the same time, foraging work - collecting pollen and nectar, propolis and water - does not affect life expectancy much.

If queen is caged in a Titov cage, she will stop laying eggs, but bees will start building emergency queen cells. Besides, a queen cannot live long in such cage. Effective reproduction regulation means the queen cannot lay eggs, but bees have full excess to its body and do not feel orphaned. To make this possible, I have designed a special devise, where queen can live for more than a year. It is patented under the name “queen isolating cage”.

A broodless colony with an isolated queen has better performance than the one with a free queen. In such colony bees stay physiologically young and can live much longer. Brood presence shortens bee life to 35-37 days (including larvae stage). On the contrary, in a broodless colony bees can live more than a year. Queen isolating cage gives us enormous advantages and new possibilities:

• to eradicate varroa mites without any medication;

• cure and prevent other disorders without drugs;

• make substantial changes in beekeeping technology to increase productivity;

• manage swarming;

• increase beekeepers’ labor productivity and economic efficiency of this branch.

# Applying reproduction regulation for sanitation

# and beekeeping technology

Wintering is one of the most difficult problems in beekeeping in colder climates. The main complication comes from a false belief that it is good to increase colony size before winter. To the contrary, colony growth in fall is harmful and should be prevented. During this period a queen does not lay a lot of eggs (as many as some would like). As mentioned before, a queen is most productive in a period with longest days. In April-June she lays the most eggs. At the end on July, however, we notice that colony growth slows down. During this time conditions for laying eggs were the best. The time when a queen slows down depends on the geographic position and climate. Thus, observing natural tendencies, we can see that it is impossible to strengthen the colony when days are getting shorter and there are fewer sources of high quality food. Therefore, mid July is naturally the best period to stop reproduction. This should be done around 15th of June. Bees that will emerge after this will have the highest live expectancy. If you haven’t isolated the queen, reproduction will slow down, weakening the colony. Intermediate generations of bees will emerge; they will require food, royal jelly and care. This will exhaust young nursing bees and lower their longevity down to 35-39 days instead of 13 months. This will cause obvious losses (about 5 kilos of honey in every colony). Thus, physiologically old bees and weaker colonies will be left for wintering.

On the contrary, if you stop reproduction at the proper time, a colony will consist of physiologically young and long-living bees that will be strong enough to survive winter. An isolated queen will not be able to lay eggs in winter, which will save the colony from most harmful winter brood, and can even kill it.

Successful wintering has to be supported by high quality food, which needs to be stored before queen isolation. Good insulation and ventilation are also important. You should remember that winter is a period when a bee colony can be saved from varroa mites. Mites will die due to the end of their physiological age, and long-living bees will continue to live. Such colonies will go through winter nicely, and get rid of all mites.

Based on mentioned facts, we can tell several periods in colony life. ***State of rest*** *–* is a period when there is no brood in the colony. ***Colony growth*** *–* period of intensive reproduction, which goes up as days get longer and slows down when days are sorter. The time when reproduction slows down can be called ***period of building up winter food stocks.*** Reproduction has been stopped, and food gathering does not influence bees’ longevity (except situations when sugar syrup is used). Besides, when bees stop reproducing, varroa mites cannot breed. Otherwise, mites go through stage of intensive reproduction, which can kill a colony of bees.

As a result, when we stop reproduction, we no longer need to apply acaricides. They might be needed when you start to use reproduction regulation method. Later, when all apiaries in certain territory will be using this method, healthy bees will not have contact with infected ones, and varroa problem will disappear.

New technology is also aiming at maximized use of nectar flow, or in other words, higher productivity of bee colonies. To achieve this, you need to isolate the queen 10 days before expected nectar flow. As a result, there will be no open brood, and bees will be free from taking care of it. This reserve of “labor force” will help to increase colony productivity.

It is also important to prevent swarming in strong colonies. This new technology gives you ability to effectively prevent swarming or use this instinct in your favor (depending on production needs).

If you notice that one colony does not work, or you can hear queen piping (sometimes it is possible), you should put the queen in isolating cage. Queen cells should be taken away every 6 days. Bees will go back to work soon. If you find a new queen cell, do not hurry to destroy it or take away. It might be that the colony goes through supersedure process.

A beekeeper can create swarming situation on purpose. It enables him to obtain high quality queens, which are needed to replace old or failing ones.

New technology also foresees the opportunity to save queens in a colony of long-living bees. These queens should be reared in June-July and used in early spring, when it is especially useful. In this case young mated queen is kept in isolating cage in a nucleus colony that lives on one honey comb. Several such nucleus colonies can spend winter in an apiary. Queens must be isolated.

# Using artificial reproduction regulation

# for pollination in greenhouses

To perform this task, brood presence is also undesirable. Brood requires extra amounts of honey, bee bread and ages bees fast. For instance, bees need to pollinate cucumbers. They can do that in a temperature no less than +22º С. This is important, because such temperature is needed to stimulate nectar flow. Sufficient illumination and root nutrition are also critical. Nectar attracts bees. In search for nectar and pollen bees travel from one flower to another, performing cross pollination. Such insemination will result in higher yield. When one of the factors is missing, pollination will not happen. Therefore the yield will be very low.

On the other hand, let’s imagine that all conditions are met, but there are no bees in the green house. In this case, all efforts are wasted and without pollination there will be no yield.

In greenhouse conditions bee colony does not have sufficient sources for feeding and taking care of the brood. It will be forced to use its internal resources, which means it will get weaker.

 Therefore, it is required to direct all colony force on pollination and free it from such burdens as brood rearing. When you place a beehive in a greenhouse, you should isolate the queen. If this colony was moved from a cool place, queen has to be isolated one day later; this will ensure that whole colony has warmed up. In this case, you do not need to feed the bees with bee bread. They will find enough pollen in greenhouse flowers. Colony will also not use much honey because there is no brood to feed.

I suggest you to try this method. At first, isolate queens in some colonies and compare the results. I am sure you will no longer pollinate greenhouses without isolating queens. The success is guaranteed. Your bees will have better longevity, honey will be effectively used, and need for bee bread will be minimal.

# Saving queens with long-living bees

We are often forced to get rid of extra queens in swarming period or in the end of summer. We feel sorry for that in the spring, when we desperately need queens for colonies which require new ones. It is possible to save those queens in favorable conditions. Usually, about 2% (sometimes up to 10%) of queens are lost after winter. Thus, we always have a necessity for extra queens in spring time. There are no young queens yet. It would be easy to take a queen from nucleus.

It is well known, that cluster of bees has to be at least 1 kilogram in order to survive winter in Ukraine. This is very costly. This limits opportunities to keep extra queens until spring time. Besides, there is no guarantee that small colonies will survive. Also, no one can guarantee that a colony with brood will survive winter. This risk is always present in traditional technology. It is explained by the fact that colonies mostly consist of physiologically old bees. They had to feed larvae with royal jelly, and are more likely to die in winter. Appearance of brood in winter or early spring is even more deadly to the colony. Thus, it is hard to guarantee that spare queens will survive winter.

Excess queens may appear during the swarming period. They are well developed. Their good quality is supported by favorable conditions. Supersedure may take place, and you have no reasons to doubt quality of new queens. It is important to be able to save these queens. This problem has to be solved, but most of so far proposed methods did not satisfy beekeepers.

The main reason for these problems is losses of bees during the passive period because of brood presence.

This drawback can be solved by using long living bees that will winter with their queen isolated in cage. This will guarantee, that there will be no brood, bees won’t have to feed their queen with royal jelly and won’t age fast.



To do that, you should create a special section, which consists of isolating cage for the queen and one comb with honey. These sections can be placed in a Dadant, Ukrainian traditional, or Langstroth beehive. You can also make a beehive, which is already split in such sections by plywood, plastic or other material. Each section has to fit frame with honey and frame with isolating cage (60mm). Entrance should allow two bees to enter; ventilation opening must be on the bottom on the opposite side (diameter 12-14mm). Such a beehive should hold at least 4 sections. Walls on the sides should be insulated with foam plastic. Walls can be made higher to create space for top insulation. Put the roof on after insulating the ceiling.

In a hive with four sections you should make entrances for each section. This will allow you to put a queen cell or virgin queen in every section. When queen has been mated and started laying eggs, it should be isolated. One comb with capped brood is installed in a section along with queen isolating cage. This will help to get long-living bees, which will be taking care of the queen. In some cases you might need to add one more comb with capped brood. Each section should be well filled with bees. When all bees have emerged, replace a brood comb with one filled with capped honey. Make a hole (diameter 12-14cm) in the middle of honey comb. In order to receive only capped brood, you can isolate a queen in a strong colony for 9 days. Obtained this way, capped brood can be moved then to one of the sections. Two frames of brood can be used as well. These frames should have some honey in the upper part too. If you have too many bees in one section they can be shacked back to the colony. It is best when each section is well filled with bees. When this is done, you should give them comb with honey and a queen cell. Queen should be isolated when she has laid more than 10 eggs. Such queen will be used when needed, usually in spring time.

If you want to save a young mated queen, you should put her in isolating cage. One frame with brood and bees, covering it should be placed in the same section. These bees are not long-living ones, so you need to have more young bees. If one brood comb was not enough to fill the section with bees, you can add another one. After that you can give them frame of capped honey.

If you are working with virgin queen, you will need 2 frames of capped brood. In 4 days young bees will emerge and will be willing to receive a new queen. When the brood comb becomes empty, it can be replaced with honey comb. The other one is replaced by queen isolation cage, which will be used only after queen starts laying eggs. Nine days after queen isolation, check for the brood she produced. If it is worker brood, the queen is mated and should be saved.

You should not allow this queen to lay more eggs than needed for testing. If the queen is allowed to lay for a longer period, this may cause following events: worker bees will be forced to feed the brood with royal jelly and become physiologically old, and therefore will have worse longevity. They will consume existing honey fast. Young bees will be weaker, and queens will not survive until winter.

The proposed method allows you to use swarming queens. They are usually high quality producers, which guarantee fast development of new colonies. This will mean that to some extend we will not be preventing swarming. It does not allow the colony to collect as much honey as they could during the main nectar flow. But it is impossible to destroy the swarming instinct because it brings new bee colonies to life. You should definitely save the queens produced by strong colonies. It will guarantee your success next spring.

One more factor to consider – the process of mating and natural conditions that influence it. It is important to have mated queens when you need them. The process is costly and pretty complex. It is better to have mated queens from the prior season than hope that you’ll succeed in rearing new ones in spring. It is also important that small colonies that were saving the queen during winter do not have foulbrood, chalkbrood and other brood diseases. They will be free from varroa mites. Having each section well filled with bees, you get a thermal conglomerate – something like a long cluster. This will prevent them from getting nosema, which is usually caused by brood presence.

In order to use a saved queen, you need to put isolating cage with queen and bees in a black paper envelope (385 by 265mm). Make a hole in front of plug on the cage. Envelope has to be large enough to easily fit isolating cage. One side can be made a bit longer to glue or staple it together.

After this you need to open the plug on the cage and put an overturned glass jar on top of it. Wait for queen to appear in the jar. When queen appears, close the jar with piece of paper. Queen can be introduced to a new colony in one of the well known ways. A nucleus colony is joined with another one preventing fights. If you want to sell queens, you can put them in special shipment boxes. They can be sold with bee a package as well. This is better done when days and nights are still cool. In this case you need to insulate them and ensure good ventilation. Therefore, there is an effective way to save and realize extra queens. Look at economic efficiency of proposed method. It will be very positive and attractive. Be creative.

Another option would be to use two honey combs instead of one. In this case isolating cage will be between them. 6mm space should be left on both sides of queen isolating cage.

Beekeeper and researcher V. Malyhin developed an interesting and useful way to supply apiary with young queens. When the temperature reaches +7° - +9° С, he joins several colonies together (weak and strong one or 2-3 weak colonies). It is easily done, since queens are caged at this time. Combs with bees are brought to one beehive if they show no hostility.

Queens in isolating cages are placed in the middle of the nest, split by combs with honey. One of emergency queens is also left in the colony (they might appear in strong colonies). When a young queen is mated and starts laying eggs, it has to be isolated as well. It happens that some of these queens are killed by the bees. But most of them will survive winter well. In spring they should be used to replace queens in other colonies as soon as bees start to fly.

# Economic and ecological advantages

# from artificial reproduction regulation technology

Complete elimination of varroa mites lowers risks for a bee colony to become weak or die. This is very advantageous for beekeeping economics. Expenses and losses caused by varroa mites are significant. Even now, when bees are well supported, it happens that mites reproduce fast due to warm and long fall. Absence of varroa mites will also help to stop spreading of infectious diseases. Killing varroa mites without medication is important, since latter are pretty expensive and lose effectiveness with time or due to poor quality. Sometimes bee colonies even get poisoned and die. Every treatment of that kind is labor-intensive and dangerous for bee health.

Reproduction regulation method is very efficient against other contagious disorders as well. It does not cost anything and begins to help bee colony even when diagnosis is not confirmed. All treatment procedures can be split in two groups: treating brood and treating adult bees. Timely application of reproduction regulation methods will help to cut losses from bee diseases, and help to rebuild the colonies. This will bring all efficiency measures up:

- saving food when nectar flow is low;

- saving food and physiological youth of bees during broodless period, including winter. In this case you can save about 5 kilograms of honey per colony in winter and 3 kilos in spring. This means 8 kilograms of honey will be saved, while bees’ health is improved;

- profit from saving extra queens until spring;

- no lost bees due to convenient swarming management techniques;

- obtaining long-living bees;

- higher productivity of bee colony during main nectar flow, since it is free from care about open brood;

- pure, health improving, and dietary beekeeping products (no contaminants such as antibiotics). This will increase their value and price;

- absence of antibiotics and other drugs in the nest should allow bees to recover their lost immunity. The main result from this is that the bees will no longer have chalkbrood. This will be a sign of recovered natural resistance to infectious diseases. It will become possible when beekeepers on large territories will be using same technology without medication. Resistance may not come back if queens will be mating with drones, which used to be treated with drugs.

It is important to obtain parenting generation that had no contact with medicines for several generations. This will become possible when continents start using reproduction regulation for production and health improvement.

# Fall reproduction is impossible

Bees have lived for centuries without any care. They would begin reproduction in spring, which would go up while days were getting longer. The number of eggs would go down when days became shorter. It is obvious, that queen activity is directly influenced by the length of the day. It has nothing to do with other factors: air temperature, availability of food, nectar flow. No matter what, size of brood goes down starting from mid July.

A colony begins to make food stocks for winter. This slows down reproduction, but is vital for survival in winter. As been discussed earlier, attempts to build up a colony in fall does not give positive results. In this case reproduction period is extended; unnecessary generations of bees are being produced. All this is very inefficient. The longer bees have brood, the more losses you will have. This will include waste of honey (at least 5 kilos of honey per colony), weakened bees, which had to feed the larvae. They have shorter longevity. Thus, queen has to be isolated in mid July. This way the youngest bees in the colony will emerge in the beginning of August. All of them will be long living and will be working in a colony for more than a year.

Therefore, reproduction regulation fits natural periods of bee life perfectly: in state of rest bees do not reproduce, than colony begins to grow rapidly, and finally starts building food stocks. Usually creating food reserves slows down reproduction. If queen is isolated, bees can concentrate on gathering food. Varroa mites are losing chases to reproduce as well. Otherwise mites breed fast in the end of summer and can kill the colony.

In this situation you need no acaricides. You should apply them only for the first time after queen isolation, when all brood has developed (in August). This will help to destroy the mite population completely. There will be no such parasites in spring. Mites from other colonies might get in, but they cannot create a serious threat because there will be only 2-3 generations of bees in 50-60 days. Next time you will need no medications at all. This is true though only if there are no mites on neighboring apiaries.

# Acquiring decontaminated wax

# for foundation production

 Steaming is one well known way to decontaminate beeswax. It is heated to 96°- 98°С for 20-24 hours to destroy vegetative forms of causative agents of disease. During entire period the temperature should not go lower than 60° - 55°С. Vegetative cells of causative agents die in 10-20 minutes at a temperature of 60° - 70°С (Chudakov V.G., Technology of beekeeping production, M. Kolos – 1979. – pg. 84-92).

Wax can also be decontaminated by gamma-rays of 2.5 millirads. This way it is possible to kill heat-resistant spores. (Smirnov A.M, Ways to sterilize packaged wax, Beekeeping magazine, 1969 № 12, pg. 15-18).

Another way to destroy spores of American and European foulbrood is to heat wax to 127° С and put it under pressure of 1.5 atmospheres for 2 hours (Grobov O.F and others, Diseases and pests of honey bees – M. Agropromizdat. – 1987. - pg. 19-41.)

However, decontamination of wax using high temperatures, killing spores, destroys the wax structure as well. About 2% of wax burns down in this case.

Gamma-rays, on the other hand, are dangerous for people.

Thus, wax processing plants are having difficult time finding efficient ways to purify wax. The main idea for a new decontamination method uses gravitation and a specific temperature regime, which extracts heat-resistant spores and causative agents from wax without destroying its structure. This is achieved by melting the wax and keeping it at 86° - 98°С. A 50 centimeter deep liquid layer of wax is settled for 2 hours.

At this temperature dirt and spores settle down fast. Lower temperatures will slow down this process. Higher temperatures, in contrast, can cause undesired changes in wax structure; and at 100ºС it will start to boil, which will move impurities up. All spores and dirt will be settled on the bottom of 50 centimeter layer of wax in 2 hours.

For example, put wax in a vessel with automatic temperature control. Warm it to 92°С, allowing temperature fluctuations from 86° to 98°С. The optimal temperature is 92°С. Wax must stay in this temperature range for 2 to 8 hours for each 50 centimeters of its depth. During this time all spores of hazardous microorganisms will deposit on the bottom because they are heavier than wax. Later, you will need to pour off clear wax without sediment. This method allows complete purification of wax.

Infection of bee colonies through contaminated wax foundation will be prevented. It is an effective way to increase productivity of bees, improve beekeeping practices and avoid losses from diseases. All this is possible without destroying wax structure by too high temperatures.

# Strategy and tactics for improving

# bee health without drugs

The basis for this strategy is artificial reproduction regulation, which helps to overcome shortcomings of traditional technology. It helps to prevent bee diseases and treat bees without medications, produce pure beekeeping products, and therefore improve the health of people as well. For these purposes, author has designed a special queen isolating cage that prevents the queen from laying eggs. This is the main approach to reproduction regulation, which should take place for technological, prevention and health improving effects.

# Defects of traditional technology

Preparation for winter becomes costly, labor-intensive and late when unnecessary generations of bees are raised. It also wastes food resources.

Brood appearance in winter time weakens bee colonies, speeds up the bees' physiological aging process and can cause death of the whole colony. Pollen resources are not fully utilized and too much honey is consumed in periods without a nectar flow.

Traditional technology also provides no guaranteed ways to manage swarming, which could make it useful for beekeeping. Beekeepers always struggle with deficit of queens in spring, and have no idea what to do with extra queens at the end of summer.

# Harmful treatment methods and lack

# of effective preventive measures

Feral bees had natural preventive and treatment mechanisms. There was no threat to their species existence. People decided that medications will improve bees' living conditions. Use of technology, convenient for people, has eliminated some natural mechanisms. For example, people began using wax foundation, which sometimes spreads infections; bees are overcrowded in apiaries; they are moved to a number of locations; the same tools are used to work with many colonies. All this promoted development of diseases, and that created a need to use medications. In most cases some kind of drug is used: antibiotics, sulfamides, acaricides, etc. These medicines are harmful for people. They contaminate beekeeping products and thus make them unhealthy. Acaricides (drugs that kill mites) are insecticides, which can kill or harm bees and other insects. All these treatments do not guarantee improvement of bee health. Most often their efficiency is not high enough. Let’s look at modern drugs, which are used to treat certain diseases and study their efficiency.

# Adult bees and brood diseases

**Varroa mites** are usually treated with acaricides. The other method is ***physical – it uses heat.*** It allows keeping bee colonies alive and working, but full recovery is never achieved. It does not contaminate beekeeping products, but is very labor-intensive. Treatment procedure requires maintenance of exact temperatures. Often it is difficult to do due to thermometers inaccuracy and other subjective reasons. It is not widely used in production due to these shortcomings.

***Zootechnical treatment method*** – requires destroying drone brood containing mites. It reduces, but does not eliminate, breeding varroa and therefore can’t solve the varroa problem. With this treatment, varroa mites continue to be constantly present in colonies of bees.

# Adult bees’ illnesses

**Tracheal mites** – an invasive disorder, caused by Acarapiswoodi that live in bee’s trachea. Folbexum is an acaricide used to kill these mites. Eight treatments are required. Folbexum (neoron) is an acaricide as well. It is applied 6 times. Menthol is used in the US and Mexico. Sometimes Apitol is applied (Cymiazole).

It is clear that any treatment that must be repeated 6 to 8 times is very laborious. Complete recovery takes a long time and a lot of effort. Sometimes treatment procedures last several years. Thus, 100% success is difficult to achieve.

**Septicemia** Most cases are treated with antibiotic: bees are fed with sugar syrup containing tetracycline or chlorine-tetracycline (300 units per 1 liter of syrup).

For disinfection, usually applied is a 3% solution of hydrogen peroxide, 1% of hydrogen peroxide, or 0.5% formic acid; Glak medication.

**Hafniosis** Diseased colonies are usually treated with antibiotics: chloramphenicol and neomycin. 200 thousands units of chloramphenicol and 0.2 grams of neomycin are applied tree times every third day. Beehives, split boards, frames and other equipment must be disinfected with 3% hot (70°С) solution of NAOH (caustic soda) with 2 hours exposition; warm solution of 3% formaldehyde can be used as well. Combs are soaked in 1% solution of iodum monochloratum for 3 hours or for 4 hours in 2% formaldehyde.

**Salmonellosis of bees** Treatment and prevention procedures are the same as for Hafniosis.

**Colibacteriosis** Treatment and prevention procedures are the same as for Hafniosis.

**Aspergillosis** Diseased colonies with obvious symptoms are destroyed. Most often they are smoked with sulphur trioxide or formalin. Beehives and equipment are disinfected with fire or 5% formaldehyde solution. Honey extractors and other tools are treated twice with solution, containing 10% hydrogen peroxide and 0.5% formic acid for 4 hours; or 10% iodum monochloratum for 5 hours. Combs are disinfected with 10% hydrogen peroxide and 0.5% of formic acid in 4 hours; or 4% iodum monochloratum is applied for 5 hours. Combs are later rinsed with water and dried.

**Melanosis** usually affects queens, bees and drones. No treatment has been developed.

**Acute and chronic paralyses** Endonuclease and ribonuclease spray is used for prevention. No treatment has been developed.

**Nosema** is conditionally pathogenic invasion. It is caused by nosema apis. The best way to save bees is prevention. The causative agent can develop and create pathogenic changes in a bee's body when bees are living in unfavorable conditions. It is hard to prevent using traditional technology. Bees, exhausted by royal jelly production, cannot withstand invasion. Presence of brood in winter or early spring usually causes nosema.

It is usually treated with fumagillin, sulfadimine, or nosematol.

***Disinvasion.*** 2%solution of alkali or soda ash is applied. Combs are soaked in 4% formalin or steamed with 80% acetic acid (200ml per 12 frames beehive).

*Nosema provokes paralyses and other viral diseases.*

**Amoebiasis** is conditionally pathogenic invasion of the intestine. There are no specific treatment methods. Usually beekeepers use fumagillin, since this disorder often accompanies nosema.

**Crithidia apis** Usually treated with sulfaguanidine. 0.5gr of sulfaguanidine is added to 1 liter of sugar syrup. Good living conditions and high quality nutrition are required. Iimproved conditions prevent it from developing as it is a conditionally pathogenic agent.

**Mmicrosporidiosis** No treatment method has been developed.

**Braula coeca** This parasite is destroyed by uncapping honey every 7-10 days. Larvae of these lice develop under cell capping. They can be killed by melting the wax. Colonies of bees can also be treated with formic acid (30-50 ml per colony); varoxan T-1 in pills; strips of Phenothiazine; and 2% oxalic acid solution. Varoabraulin is applied in spring and autumn 3-5 times every 6-7 days.

***Brood diseases***

**American foulbrood** Bees are usually treated with 1 liter of sugar syrup with norsulfazole sodium (1-2gr), neomycin, tetracycline, erythromycin, monomysin, or kanamycin (400 thousands units), chlorine-tetracycline or streptomycin (500 thousands units). All healthy looking colonies at the apiary are treated 3 or 4 times for prevention. ***Disinfection*** is carried out simultaneously with treatment of bees. Wooden parts of infected beehives are fired with a blowtorch until they turn light brown. They can also be sprayed with one of these solutions: 10% hydrogen peroxide and 3% formic acid, (1 liter per one square meter, applied for 3 times every hour). Later these beehives can be used for production purposes; no need to rinse them with water. A warm solution (30-40°С) of 5% formalin and 5% caustic soda can be used too (0.5 liters per 1 square meter, apply twice with one hour interval). Five hours later these objects are rinsed with water and can be used. Combs are usually sprayed with 3% hydrogen peroxide and 3% formic or acetic acid. 3% solution of iodum monochloratum can be used as well. Combs should be soaked for 24 hours, then rinsed and dried. Honey extractors are washed with water and a hot solution of 5% formalin and 5% caustic soda (1 liter per 1 square meter). Five hours later it is rinsed and dried as well. Wax can be disinfected using patented technology № 10100 of P.Y. Khmara and L.I. Bondarchuk.

**European foulbrood** Treatment and prevention are same as for American foulbrood.

**False foulbrood** It is usually treated with erythromycin, chloramphenicol, and neomycin (400 thousands units per 1 liter of sugar syrup). This mixture is fed to the bees (100-150ml per frame) every 3 to 7 days until they recover completely. Sodium norsulfazole (1gr) with neomycin, erythromycin, or Oxytetracycline (200 thousands units, 100ml per frame) is applied for the same period. ***Disinfection*** is the same as against American foulbrood.

**Sacbrood** The recommended treatment is to feed bees sugar syrup. Hyperimmune serum obtained from rabbits and horses may also be added to sugar syrup. It is hard to find when needed though.

***Disinfection***: 4% hydrogen peroxide, 2% hypochlorite, and 1 % formaldehyde is applied for 4 hours. Treated objects are later rinsed with water and dried. Combs are disinfected with 4% hydrogen peroxide or 1% solution of formaldehyde for 3 hours. They need to be rinsed and dried as well. Wax can be melted in water bath at 70°С for 70 minutes.

# Improvement of beekeeping technology

# by artificial reproduction regulation

One of the most important periods for beekeeping is winter. A similar state of bee colony dormancy can be reached during the active season when there is no nectar flow. Periods with unfavorable environmental conditions are in many ways similar to winter.

Thus, bee colonies located around 50 degrees of northern latitude should be prepared for such period in the middle of May, if apiary is located in non-mountainous region. Altitude above sea level is an important factor of climate formation. Climatic characteristics should be considered. Similar operations will take place earlier in the south and later in northern regions.

Bees should start preparing for winter when the amount of brood is declining. For example, in the beginning of July average colony works on between 7 and 10 brood combs. In August their number reaches 4 or 5, and only 2 or3 in September. The so-called “colony buildup” does not happen in fall. Bees use too much honey and bee bread to raise unnecessary generations. This means they enter winter physiologically old and weakened. Brood in fall can cause losses only. Food resources are wasted when reproduction is not stopped. Bees become short-living due to exhaustion from royal jelly production.

Therefore, reproduction has to be stopped in the middle of July by putting queen in specially designed isolating cage, invented by Khmara P.Y. The immediate result of queen isolation is decline in brood volume.

By this time each colony must store at least 3 kilos of capped honey. Between 6 and 8 combs of such honey are needed for winter. Bees should cover tightly all combs in the nest. The queen in the isolating cage is usually placed in the middle of the nest. When air temperature goes down to 7° С we can easily see how many frames are covered with bees and take away extra ones. Bees that cover comb on one side should be shaken off to form compact cluster. Each comb in the winter cluster should have a hole in the middle of the box (or better, 2 centimeters higher than the middle). Its diameter should be 12-14 mm to allow easier access for bees from one frame to the other. The nest is confined by split boards and insulated. Approximately 2 or 3 centimeters space between side boards and the floor is left for better ventilation. These steps help to obtain long living bees, which will survive winter well when high quality food is available. ***The colony will be free from varroa mites in February.*** ***The mites will perish if the queen has been isolated in mid July.***

Such wintering conditions allow saving up to 8 kilos of honey per colony (at least 5 kilos in fall and 3 in spring), complete destruction of varroa mites, and fast development of colonies in spring and summer. Bees will stay broodless even during warm winters.

***Better use of a nectar flow can be achieved as well.*** Reproduction should be stopped 9 days before an expected nectar flow to increase bees’ productivity. Queen should be released in 5 to 7 days after beginning of nectar gathering. Queen can be isolated for 9 more days (if possible) to simplify honey extraction. In this case there will be no open brood. When nectar producing plants are expected to bloom by the end of August, honey can be extracted. For instance, buckwheat in Kiev region blooms till mid August. During this period we can take the appropriate amount of capped honey and use it to form winter nests. Extra honey can be extracted. Each full depth comb in a winter cluster will contain about 3.5 kilos of honey (435 by 300 mm frame).

# Using swarming to obtain high quality queens and its regulation

# for production needs

Swarming and supersedure queens are the highest quality. This is explained by the fact that everything in a bee colony, from starting a cell until queen emergence, is devoted for its best development. This state can be artificially promoted in a strong colony to obtain high quality queen cells.

When queen cells are capped, they can be moved to nucleus or other colonies to replace failing queens. Extra queens should be saved until spring. This is very useful. Swarming regulation can be a forced procedure when a colony reaches this state during a time that is poor for honey production. In this case queen should be isolated in a cage, and queen cells taken away every 6 days. Other advantageous decisions can be made as well.

# Brief plans for bees’ health

**Varroa mite**

Bee health improvement is reached by breaking the life cycle of mites, using difference in life span of bees (396 days) and mites, which can live only for 160 to 180 days (Khmara P.Y. 2005). Since mites can only breed in bees’ brood, they cannot reproduce when bees are broodless. Young bees with parasites will emerge In 21 days after queen isolation. Mites will die in 160 days if born in July, and in 180 days if appeared in September. Thus, if reproduction of bees was stopped on August 1st, all mites will die by the end of February. Reproduction is normally renewed when bees start to bring pollen (April in Kiev region).

A bee colony, treated this way can only get mites from other colonies no earlier than June. These few mites will be able to rear about two generations by August 1st. Therefore, acaricides might be needed. All this should be carefully studied. Please, contact the author is you have some interesting results. Different timing for reproduction stop might have different affect on bee colonies. However, presence of mites in neighboring apiaries might require additional treatment.

**Adult bee diseases**

***Tracheal mites (Acarapis woodi)*** Bees are cured by isolating the queen for 9 days. After this time there will be no unsealed brood in a colony. Capped brood has no Acarapis woodi. The sealed brood is taken away, preferably in warm weather (between 25С and 35С). It is used to create new colony without worker bees. Each nest receives at least 4 brood combs. They are sprayed with Folbex BA to kill mites that might be on the surface. A new queen is introduced after 3 to 5 days. Twelve days later we have a new, healthy colony.

***Septicemia*** Bees are treated with a similar method as that used against tracheal mites. Combs with capped brood are sprayed with warm water solution of tetracycline or chlorine-tetracycline, using 300 thousands units per 1 liter of water. Combs, frames, and beehives are disinfected with 3%solution of hydrogen peroxide or 1% hydrogen peroxide and 0.5% formic acid, or Glak.

***Hafniosis*** The treatment is similar to that used for tracheal mites. Combs with capped brood are disinfected with chloramphenicol 9200 thousands units) and neomycin (0.2 grams). A warm water solution without sugar is used. Disinfection of beehives, frames and boards is done by exposing the equipment to a hot (70°С) solution of NAOH (caustic soda) – for 2 hours. A 3% warm solution of formaldehyde can be used as well. Combs are treated with 1% iodum monochloratum for 3 hours or 2% formaldehyde for 4 hours.

***Salmonellosis and colibacteriosis*** Treatment and prevention measures are same as for hafniosis.

***Aspergillosis*** It affects brood and adult bees. Treatment measures are described in chapter on brood diseases.

***Melanosis*** Treatment is same as for tracheal mites.

***Acute and chronic paralyses*** Queen must be isolated for 9 days. Capped brood is taken away in warm or hot weather. It is used to create new colonies my joining it with queens from healthy colonies. This treatment procedure is similar for all disorders of adult bees.

***Nosema*** Queen must be isolated for 9 days. Capped brood is used to form new colonies. In cool temperatures it is required to maintain a temperature of 35°С in the nest. A queen is introduced after 2 or 3 days. The hive entrance is closed with screening for 7 days. Half of all bees will have emerged by this time. If new colonies are kept in a warm room, they should be given sugar syrup in combs. After 10 days they can be moved outside, and entrances can be opened.

Disinfection is done by 2% solution of alkali or soda ash. Combs are treated with a 4% solution of formalin or steamed with 80% acetic acid (200 ml per 12 frames beehive).

***Amebiasis*** The queen is isolated for 9 days. New colonies are formed from capped brood. Temperature in the nest should be 30° - 35°С.

***Braula соеса*** To destroy this parasite, we need to cut cappings off all honey in the nest every 7-10 days.

**Brood diseases**

***Sacbrood*** The Queen is isolated for 21 days, assuming there is only worker brood in the nest. If drone brood is present, it should be cut out, or the queen isolation prolonged for an additional 3 days. Later all bees are moved to a clean beehive with disinfected combs. A queen from a healthy colony is introduced. Disinfection is done by exposing equipment to a 4% solution of hydrogen peroxide or 1% formaldehyde for 4 hours. Wax is melted in water bath at +70°С for 70 minutes.

***American and European foulbrood*** The queen is isolated for 21 days. Queen isolation is prolonged by 3 days if drone brood is present. Later all bees are moved to a clean beehive with disinfected combs. A queen from a healthy colony is introduced. Equipment is disinfected with fire. Combs are treated with a 3% solution of hydrogen peroxide and 3% formic acid, or 3% iodum monochloratum. Other tools are disinfected with 5% formalin and 5% caustic soda.

***False foulbrood*** Treatment is same as for American and European foulbrood.

***Chalkbrood*** Treatment is same as for foulbroods. Beehives and combs are disinfected with 10% hydrogen peroxide 0.5% formic acid for 4 hours, or a 10% solution of iodum monochloratum for 5 hours.

***Aspergillosis*** If brood is diseased, it is treated same as for foulbroods: beehives and tools are disinfected with fire or 5% formaldehyde. The rest of the treatment is the same as for chalkbrood.

Short treatment schemes are described for immediate correction of health problems. This makes them very useful.

# An annual operating plan for artificial

# reproduction regulation technology

Timing of reproduction regulating operations will vary depending on location and other conditions. Thus, it is easier to define seasons for certain procedures.

**Spring** is a good period to start reproduction. Weather conditions will influence the timing. Bees should be able to maintain warm temperatures necessary to raise brood. It is easy to achieve when pollen producing plans start to bloom. This is the best time to release the queen from isolating cage. Bees should be supplied with sufficient amount of warm comb, fresh pollen or bee bread, honey, and water. The queen will lay many eggs, and the colony will start building up fast. This process is stimulated by physiological youth of bees.

One of the most important factors of effective beekeeping is ability to utilize early pollen and nectar sources. When this is not possible, bees are fed sugar syrup and pollen substitutes. A better idea though, is to move bees to another location that provides them with more natural food.

 An apiary can be productive and efficient when natural products such as nectar, honey, pollen, and bee bread are available. Artificial stimulators can be dangerous for bees and peoples' health. Only naturally fed bees stay productive and healthy. Stimulators do have some effect at first, but later they may cause a lot of negative effects.

Spring is a time when the basis for bee colony existence is created. The beekeeper should do everything possible to maintain healthy and active life of these tireless workers.

By the end of spring bees will tend to swarm. This process can be managed in ways described earlier. It can become a profitable event for a beekeeper. Spare queens obtained during swarming season can be saved. This possibility is described in a chapter “Saving queens with long-living bees”.

A beekeeper should wash his hands with common soap before working with bees. Toilet soap usually has a strong smel that often causes aggression in bees. A queen that smells like perfumes can be attacked by colony members. This can even cause her to die.

A lot of well known diseases may appear in spring time. This book gives you plans for fast treatment procedures using artificial regulation method. All actions should be done on time.

The same method can be used to increase productivity during nectar flow. Other operations may be needed as well.

**Summer** is a season when you need to ensure buildup of colonies strength to prepare them for broodless period. This means that queens should be able to lay as many eggs as they can. They need a sufficient amount of empty combs and a stable temperature in the nest. This is especially important when days are getting longer. If there is low or no nectar flow in this period, colonies should be fed with sugar syrup. Also you can move your apiary to a better location to ensure their good development. To ensure fast reproduction you need to have reserve combs. Capped honey should be taken away on time.

Summer diseases can be treated using same method as described for spring time. Hot summer weather is the best time to treat bees against adult bee disorders such as tracheal mites, septicemia, paralyses, and intestine diseases. Spare queens should be saved as mentioned above.

Reproduction of bees should be stopped in the end of summer. All bees should emerge in within the first ten days of August. Stopping bees’ reproduction makes varroa mites reproduction impossible as well. Queens should be isolated in the beginning of July. This is very useful for the bees and beekeeper. If a nectar flow is available at this time, it will not weaken the colony. Let’s compare two situations in detail. If queen is not isolated, bees will collect nectar and take care of brood. The youngest larvae will be fed with royal jelly, which will physiologically age nurse bees. Nectar collection, on the other hand requires energy only. The energy source is honey. However, use of protein compounds for honey digestion is substantially lower than during production of royal jelly. Besides, a colony with an isolated queen has much better performance, since all bees were born in favorable conditions and stayed physiologically young.

**Fall.** At the time of queen isolation each colony should have sufficient amount of honey for winter. All honey should be capped. Each comb should weight between 3 and 3.5 kilos. Do not leave empty combs in the nest. Bees should cover all combs tightly to ensure proper temperature in winter cluster. The queen in her isolating cage is placed in the middle. Split boards and insulation should be installed as well. Weak colonies can be joined together. It is easily done when temperature goes down to 7°С. When you join two colonies queens should stay isolated as well. In these conditions bees will not notice bees from other colonies because the queen pheromone does not evaporate at such low temperature. Queen isolating cages are placed in the middle of the nest with one honey comb between them.

You should make sure the apiary is prepared for winter, or create a special room for wintering bees. Beehives are moved inside when the temperature drops and flying is not expected until spring. Beehives should be protected against mice and other rodents.

 It is useful to put a piece of paper on beehive floor to control number of dead mites and observe processes in winter cluster.

**Winter.** Bees should be monitored by listening to their activities. The number of mites is checked. Changes in winter conditions may require additional actions.

# Biological characteristics of bees

***Understanding bees' activities and colony equilibrium***

A colony of bees is a community. It exists as super-organism where queen is the only fully developed female bee. Workers are also female bees, but they are underdeveloped, non-reproductive, females. They provide the colony with everything it needs. They forage and feed the brood.

Brood is produced by the queen, which can lay diploid and haploid eggs. Drones are developed from haploid eggs.

Diploid eggs are the fertilized ones. Female bees and queens develop from these eggs. Food which they receive determines if it will become worker bee or a queen.

The bee larva hatches out 72 hours (3 days) after the egg is laid. The brood nest temperature should be 34.5ºС - 35ºС. The same period is required for queen and drones larvae to hatch out. A queen larva is fed royal jelly for 5 days and is capped on the 6th day. The new queen will emerge in 8 days. Thus, to raise a queen you would need 16 days.

A worker bee is born in 21 days after egg is laid. The process is following: 3 days for egg incubation, 6 days of feeding larva (first 3 days larvae receives royal jelly, later – honey and bee bread with water). Then 12 days as a pupa in a capped cell before emerging.

Drone development stages are: 3 days for egg incubation, for next 3 days larvae receives royal jelly, 4 days it is fed with mixture of honey, bee bread and water, and 14 days – capped in the cell. Twenty four days total.

As a result, queen development takes 16 days; worker bees take 21 days, and 24 days for drones.

Being in a capped cell during metamorphasis, the queen, worker bee and drone pupa require only warmth and proper humidity. The temperature should be 34.5ºС, and relative humidity near 60%. If the temperature goes down, development may take longer, and if it goes up, development may be faster. Fluctuations should be minor, though.

 A harmonious colony is the one that has a queen and optimal number of worker bees. In winter an average colony consists of between 15 and 20 thousand bees. The optimal size of a colony is 30 thousand bees, with a minimum of 10 thousand bees. Small colonies cannot develop fast in summer. It has a better chance to survive winter if placed near another colony split by a thin board or net.

Drone production is a temporary condition, raised by the colony to mate with young queens. Usually there are several thousand of them in the colony. They should not be killed. When there are not enough drones, the queen will start laying eggs in drone cells (they are larger than worker cells). The number of drones can be limited by removing some of drone brood. This will allow saving some royal jelly and other food.

Raising worker bees, queens and drones is very costly for the colony. If comb has too many drone cells, it should be replaced and melted down. Each new generation of bees causes losses for beekeeper and is hard on bee colony. Limiting the number of produced bee generations is very advantageous.

Glands on the head and chest of a bee are very important for its life. They regulate reproduction and lifespan. Maxillary glands are located on the head, at the bottom of maxillary bone. They are formed by two bilobular sacs. Their ducts open where mandibles are attached to the head. These glands emit a special substance that is present in royal jelly. Queen mandibular pheromone is licked off her body by worker bees and spread out in the colony. Pharyngeal glands are located in front and behind visual clasps. These glands also secrete one component of royal jelly. Besides, they secrete invertase, which is important for splitting sucrose and nectar into glucose and fructose.

# Peculiarities of bee biology proving the need for artificial reproduction regulation

1. Queen development cycle is 16 days:

 - egg incubation - 3 days;

 - feeding larva - 5 days;

 - capping queen cell – on 8th day;

 - young queen emerging on 16th day.

2. Worker bee development cycle is 21 days. It is a female bee as well. It develops from a diploid egg.

 - egg incubation - 3 days;

 - feeding larva - 6 days;

 - capping worker cell – on 9th day;

 - imago bee appears in 12 days.

3. Drone development cycle is 24 days:

 - egg incubation - 3 days;

 - capping drone cell –in 10 days;

Thus, in order to obtain capped brood only, you need to isolate the queen for 9 days.

This situation can be used to take away capped brood from diseased colony. This healthy brood can become a new healthy colony.

All this process is better explained in the table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stages | Egg | Larva | Prepupa and pupa (capped) | Total number of days |
| Queen | 3 days | 5 days | 8 days | 16 |
| Worker bee | 3 days | 6 days | 12 days | 21 |
| Drone | 3 days | 7 days | 14 days | 24 |

# The need and application possibilities

# for the artificial reproduction regulation method

There are global and strategic needs for application of this new method. Use of artificial reproduction regulation in a separate region (continent) will have differences. It will depend on the climate, vegetation, and availability of nectar and pollen producing plants.

In regions with cold winters, bees should be thoroughly prepared for winter by supplying long living bees with substantial amount of high quality food. Dates for operations described can vary by 10 days throughout Ukraine. In other regions or continents they will be different.

If reproduction is stopped between the 10th and 15th of July, the youngest bees will emerge in the beginning of August. The queen should have enough empty combs during the period when colony growth is highest. If bees are filling the combs with nectar, you should add emptier comb. You can use spare ones or extract honey and put them back. This will support reproduction. If colony growth is not one of your priorities, you can skip these operations. But you need to remember that a weak colony cannot expand in a period when days are getting shorter. This means that there might be not enough long living bees by winter. A colony of bees that has brood by the end of September will mostly consist of physiologically old bees in winter. Their lifespan and productivity will be low. This may result in nosema problems and substantial losses in winter time. As a result, it will have poor performance next season as well.

It is interesting to study the correlation between colony strength and climate. In places with cooler climates, where length of the day differs much during the year (in high geographic latitudes), colonies of bees enter winter stronger. In lower latitudes, closer to equator, colonies are weaker before winter. There is a simple logic to it: weak colonies cannot sustain frosts, thus only strong colonies live in these regions. The relationship can be explained in a following way: Length of the day plays an important role. In spring days are getting longer very fast in higher latitudes. This allows bees to get stronger faster than in lower latitudes. Later, days are getting shorter rapidly. The queen starts to lay fewer eggs. A short reproduction cycle, when bees do not raise unnecessary generations, ensures a better condition of the bee colony. These colonies have more long living bees that did not need to produce royal jelly.

If you’ll see any way to improve described method, this author will be happy to discuss it by phone, mail, press or any other way. You should understand that we are only beginning to develop this new beekeeping technology. All inventions can be improved. I invite you to participate in this process. Biological science is aimed to study life. This sphere should be entered carefully. Do not rush with conclusions; share your experience with colleagues. Propagate all information that you consider useful. I am grateful to all supporters and interested beekeepers that are ready to review old beekeeping technologies and start improvements in this branch.

# Scientific author's achievements

1. Based on concept of various life spans of the bees described by A. Mauricio (1958), the author has created a method for its management in a colony of bees.

2. A science-based artificial reproduction regulation method has been developed. The important fact is that continuous reproduction increases the number of bees and reduces their lifespan by a factor of 10. When reproduction is stopped, life expectancy of bees goes up.

3. A science-based method for the creation of long-living bees has been created.

4. Author has built and patented a devise named “queen isolating cage”. It is an instrument that is used for reproduction regulation.

5. A method for estimation lifespan of varroa mites has been invented.

6. Different longevity has been noted in varroa mites. Mites, who appeared in July live for 150 days, in August – 160 days, in September – 200 days, and in October – 250 days. This data is relevant for Kiev and similar regions of Ukraine.

7. A science-based method for complete (100%) elimination of varroa mites has been developed. It requires no medication and based on life span of mites (it is shorter than lifetime of long living bees). Long living bees can stay alive for 396 days. This is a new method for curing bees without medications.

8. The author has described a possibility to destroy varroa mites on a whole planet and is hoping for support of this idea.

9. A science-based method for treating infectious diseases of brood has been developed. It is based on artificial reproduction regulation.

10. An innovative technology has been invented to treat adult bee infectious disorders without medications.

11. A technological treatment of bees against most diseases without application of medications allows us to obtain uncontaminated beekeeping products. They become health improving for people.

12. The impact of medications on bee body has been proven scientifically. No medication treatment method improves bee immunity or can stop their extinction from virus diseases. CCD syndrome proves that further use of medicines can cause bees dying out. This will leave most entomophilous plants with no pollination, which means hunger and death of people. Einstein predicted that the human species would die in four years after bees disappear. Therefore, without bees there will be no mankind.

13. The priority of prevention measures in colonies of long living bees has been validated. There are no conditions for development of varroa mites and nosema in a colony of physiologically young bees. Nosema can appear only if bees are fed with low quality food, poison or excess humidity.

14. Beekeeping technology has been improved. Halting bee reproduction allows having no excess generations of bees, which means they do not need to produce as much royal jelly, thus saving food and increasing honey production. Profitability will be even higher if good nectar sources are available.

15. Reproduction can be stopped to overcome unpredictable (drought, cold weather, etc.) or expected factors such as lack of blooming nectar producing plants for a long period.

16. The author has described ways to use reproduction regulation to manage swarming condition.

17. Unique results of wintering several queens in one cluster have been obtained.

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