UDC 638.145.5 https://doi.org/10.31548/animal2020.02.005

HIGH TEMPERATURES AND THEIR EFFECTS ON PLANTS AND BEES

V. D. BROVARSKIY, *Doctor of Agricultural Sciences, Professor, department ofHorse-Breeding and Beekeeping*
https://orcid.org/0000-0003-2495-2084
E-mail: vbrovarskiy@ukr.net
National University of Life and Environmental Sciences of Ukraine
A. T. TURDALIEV, *Doctor of BiologySciences,Docent, Head of the Department of Soil Science*
https://orcid.org/0000-0002-6119-5214
E-mail: avazbek1002@mail.ru
G. I. MIRZAKHMEDOVA, *Assistant,department of Soil Science*
https://orcid.org/0000-0002-5946-1894
E-mail: mirzaxmedova17@bk.ru
Fergana State University, Uzbekistan

Abstract. *The analysis of the effect of high ambient temperatures on entomophilous plants and honey bees is carried out.The research of the species composition of entomophilous plants, the timing of their flowering, of the temperature peaks during the summer was conducted in accordance with the conditions of the Fergana region, Uzbekistan. The ethological behavior of bees at high temperatures was carried out at Holosiivska educational and research apiary of NULES of Ukraine. Trere were used generally accepted methods at experiments. According to the research results, the maximum ambient temperatures for Fergana, Uzbekistan were determined. It is established that according to conditions of the Fergana region of Uzbekistan, honey plants and bees are most exposed to high temperatures during the second half of summer. It was analyzed the species variety of entomophilous plants of the Fergana Valley. The most common species of plants by areas of their dissemination have been identified.Plants are grouped in each zone, subject to influence of high temperatures during their flowering period.The effects of heat on the flight activity of worker bees and their behavior are determined. During the day, under the influence of high temperatures, the bees of the families did not show the same activity to flying. They actively fly off in the morning. As the temperature increased, the number of departures was decreased. This often happened from 11 a.m. to 6 p.m. During this period, the aggressiveness of bees in the colonies increased. They more often visited drinking bowls and brought water. In addition, bees actively ventilated the nests. Some of them opened the nest and hung on the walls of the hive.Under prolonged exposure of high temperatures, worker bees hung in bunches on the walls of the hive even at night. This behavior of bees lasted until the temperature dropped to 28 °C and below.Given to the negative impact of global warming on flora and fauna, it is increase the importance of honey bees as part of the biocenosis of wildlife, the likelihood of extinction of many species of plants and animals. It is concluded that it is necessary to improve the ecology, to deep research related to the effects of high temperatures on honey bees and entomophytic plants.*

Keywords: *ambient air temperature, honey plants, honey bees.*

Introduction.

About 87 % of all plant species can disappear from the Earth without pollination by insects. Man has already destroyed many species of pollinating insects or moved them to the Red Book. The main work in pollination is now done by bees. It has become quite obvious that extinction of bees is a very serious problem for humanity.

The patterns of life of bees were formed starting from the Kanozoisky stage (the first half of the Paleogene period). Alongside with the development of the world's flora, the way of bees' life was born and improved, which gradually switched from individual (single) existence to group – social.

For over 40–100 million years, honey bees adapted to various climatic and honey-gathering conditions, developed a number of conditioned and unconditioned reflexes aimed at the survival in society (Brovarskyet al., 2016). Unfortunately, due to active exploitation of natural resources, people significantly affect the environment. Irrational use of land, introduction of intensive technologies for the production and processing of products, the use of genetically modified organisms, biologically active and hormonal drugs, chemicals and other factors have significantly worsened living conditions of honey bees. Over the past few decades, around the world, in addition to a abrupt decrease of the number of bee colonies, there has been a decrease in their productivity and resistance to diseases.

Analysis of recent researches and publications.

Due to many factors appearing mainly because of man's activity, global changes are taking place on our planet. They negatively effect on biogeocenoses and ecosystems. An example of such negative effect is death of honey bees and the deterioration of their living conditions.

Bees have died before from diseases and pests, violations and non-compliance to the technology of their maintenance, lack or poor quality of feed, weather disasters and etc. Now, ecology is a burning problem, and first of all poisoning bees with pesticides, reducing of the area and species composition of honey plants, global warming, electromagnetic fields, fires etc. Perhaps these negative factors are the reasons of the "bee death syndrome". In many countries, the number of bee colonies has decreased significantly. What causes the bees to die out has not been fully found out and therefore, there are many different assumptions(Brovarsky and Papchenko, 2014; Gainov, 2011; Pashayan and Makvetsyan, 2019).Probably global warming may also be one of the decisive factors of the negative impact on bees and their death (World of beekeeping, 2014; Hussein, 2012). Therefore, our chosen field of research is important both fromtheoretical and practical points of view.

The aim of the research is to analyze the effect of high temperatures on the conditions of bee colonies and honey plants.

Materials and methods.

Research and analysis of the obtained material was carried out in the Ferghana region of Uzbekistan (Ferghana State University), some experiments were done at the Goloseevskaya training experimental apiary of the National University of Life and Environmental Sciences of Ukraine in 2019. In this work, we used our own observations regarding the effect of ambient temperature

on entomophilous plants and bees. The dynamics of the ambient temperature in the zones of keeping bee colonies was analyzed based on Uzhydromet data, the flowering of plants were determined using the generally accepted method (World of beekeeping, 2014; Brovarsky, 2017). The study of the species composition of entomophytic plants, the timing of their flowering, peak temperatures during the summer was conducted in accordance with the conditions of the Fergana region, Uzbekistan.The influence of various environmental temperatures on colonies was carried out by observing the flight activity and behavior of bees, both on the nest cells and in the space near the hive entrance. Ethological behavior of bees at high temperatures was carried out at Holosiivska educational and research apiary of NULES of Ukraine. General methods were used in the experiments (Taranov, 1961; Perry et al., 2015).

Results of research and discussion.

Probably, global warming and food resources can also significantly affect the vital activity of bees and cause their death. Many symptoms ofnegative effects of global warming are already reflected in changes in nature. For example, for many years in the winter, there was less rainfall, and the temperature was much closer to zero. Under such conditions, the soil freezes just slightly. Therefore, in early spring, the beginning of vegetation of plants with different depths of the root system begins almost simultaneously. Some types of plants can bloom even several times during the warm season, for example, *Malus domestica*, *Aesculus hippocastanum*, *Robinia pseudoacacia*.

In all regions of Ukraine, beekeepers complain that even at the end of flowering of fruit trees, *Robinia pseudoacacia* blooms and a little later blooms different types of *Tilia*. Changing in the flowering of main honey plants in earlier periods leads to the fact that in the first half of summer, bees do not have sources for replenishing of carbohydrate feed. Without sufficient feed reserves, bees reduce or even stop the construction of honeycombs, reduce brood rearing, and their preferential activity decreases. Having suspended all work, they drive out drones, and then gradually die from hunger. In order to somehow provide the bees with feed or to have an additional amount of marketable honey, beekeepers have to look for sources of honey collection and bring bees to these colony of plants. Doing this is really difficult. After the abolition of planned agriculture, today nearly only *Brassica napus* and *Helianthus annuus* from honey plants are grown on arable land. The first honey plant blooms in spring, and the second – in the second half of summer. To find at least areas (20-30 ha) under crops of previously widespread crops such as *Trifolium pratense*, *Fagopyrum esculentum*, *Onobrychis vicifolia*, *Coriandrum sativum*, *Phacelia tanacetifolia*is problematic.

The next, and probably the least studied problem is the effect of high temperatures on plants and bees. Today in the scientific literature you can find a lot of the materials related to the effect of low temperatures on the conditions of bees during the wintering period and on plant resistance. But the issues of effect of high temperatures to bees and plants are covered very poorly.

The development of entomophilous plants, the vital activity of honey bees and the relationship between them is possible only in a certain (comfortable) temperature range. Most species of mellifer-

ous plants bloom and accordingly secrete nectar in the temperature range from 18 to 28 ^{0}C. However, there are few species of plants that bloom at significantly lower temperatures (*Galanthus nivalis, Viola reichenbachiana, Pulsatilla patens, Tussilago farfara, Crocus vernus*) and are more heat-loving or, more correctly, heat-resistant (*Berberis vulgaris, Convolvulus arvensis, Asclepias, Centaureascumususus Salvia officinalis, Veronica officinalis, Echinacea purpurea, Lupinus albus, Gossypium hirsutum, Alhagi pseudoalhagi* and others).

The resistance of plants and bees to the action of high temperatures (like other living organisms) is based on a special property of the structure of protein molecules - a combination of strength and flexibility, which allows them to maintain structure and functional activity in extreme conditions. But we will not involve into the physiology of these processes, but simply analyze the effect of high temperature on bees and plants.

As an example, we give the data of Uzhydromet, which indicate that in some regions of Uzbekistan in the second half of the summer of 2019, the air temperature on some days exceeded +47 ^{0}C, and in the Ferghana Valley the thermometer even reached +56 ^{0}C. In the city of Ferghana itself, the highest temperature was in July and the first decade of August (table 1). In recent years, summer in Ukraine also have very hot days, when the temperature reaches +40 degrees or more. Typically, this temperature is not set for a short period of time (1-2 hours), but acts over a long period, which is more dangerous for living organisms.

I would like to remind that changes in the molecules of some proteins are already at + 40^{0}C, although denaturation for most proteins begins at a temperature of + 50 ^{0}C.

In hot weather, plants lose a lot of water, they have metabolic and photosynthetic disorders. Due to high temperatures, plants reduce or stop releasing of nectar. If the plant produces nectar, then it quickly loses moisture and becomes too thick. It is increases the concentration of sucrose.

Usually, bees collect nectar, where the sugar concentration is 50-55 %. The concentration of sugars is less than 17 % or, conversely, an increase in their number more than 60% leads to a reduction in the flight activity of bees or even to a stop in the collection of nectar. High temperature, low air humidity, lack of pollination significantly affect the formation of plant ovaries, seed germination, species conservation in ecosystems etc.

Many plants in the Ferghana Valley of Uzbekistan bloom precisely at a time when the ambient temperature (table 1) can negatively affect to the processes of nectar production and, as a result, to their pollination (table 2).

Unfortunately, in the literature on beekeeping, scientists do not pay attention to the effect of low and high temperatures on the production of nectar. It is obvious that hot weather affects no less adversely on bees. In the summer, honey bees maintain maximum temperature in their nests only in the brood concentration zone (central or brood part of the nest). On these cells, the temperature ranges from 33 ^{0}C to 35 ^{0}C. Even a slight decrease or increase in temperature in this part of the nest can lead to disruption of the development processes of the brood or to its death.

Unfortunately, in the literature on beekeeping, scientists do not pay attention to the effect of low and high temperatures on the production of nectar. It is obvious that hot weather affects no less adversely on bees. In the summer,

1. The maximum air temperature in Ferghana during the summer period of 2019, °C (data from Uzhydromet, Fergana city)

Day	Month		
	June	July	August
1	2	3	4
1	31	39	38
2	28	29	37
3	29	33	38
4	30	35	37
5	30	36	39
6	26	37	39
7	31	37	40
8	28	32	37
9	33	35	33
10	19	38	35
11	26	38	36
12	28	39	37
13	31	40	33
14	34	40	32
15	32	40	30
16	34	40	30
17	34	40	30
18	34	39	30
19	33	41	32
20	33	39	33
21	35	40	33
22	34	39	35
23	33	39	34
24	35	38	32
25	35	37	34
26	36	36	35
27	34	35	35
28	34	37	35
29	35	39	36
30	33	36	32
31	–	38	30

honey bees maintain maximum temperature in their nests only in the brood concentration zone (central or brood part of the nest). On these cells, the temperature ranges from 33 °C to 35 °C. Even a slight decrease or increase in tempera-

2. Some honey plants of different zones of the Ferghana Valley and their flowering periods

Name of the plant	Flowering period	
	start	end
Foothill area		
Ranunculus repens	1 decade of May	2 decadeof June
Eremurus robustus	1 decade of May	2 decadeof June
Acanthophyllum elatius	from3decade of May	3decadeof June
Brassicacampestris	from3decade of May	before3decadeof June
Medicaqo lupulina	from beggining of May	beginning of July
Sisymbrium isfarense	end of 1 decade of May	2 decadeof June
Capparis spinosa	from beggining of May	end of August
Onosma baldshuanica	1 decade of May	1 decadeof June
Trifolium lappaceum	from beggining of May	1 decadeof July
Trifolium fragiferum	from beggining of May	1 decadeof July
Psoralea drupacea	from beggining of May	1 decadeof July
Polygala hibrida	end of May	June
Althaea officinalis	end of May	middle of July
Althaea cannabina	end of May	1 decade of August
Eryngium macrocalyx	beggining of July	end of August
Cousinia resinosa	beginning of June	end of August
Scabiosa songorica Schrenk.	beginning of June	end of June
Centaurea squarrosa	beginning of June	middle ofAugust
Alhagi pseudoalhagi	beginning of June	middle ofAugust
Desert area		
Acanthophyllumpungens	beginning of June	end of 2 decade of August
Psylliostachys leptostachyus	beginning of 3 decade of May	end of 2 decade of June
Convonlvulus hamadae	beginning of 1 decade of May	end of June
Halimodendron halodendron	1 decade of May	end of July
Kareliniacaspia	beginning ofJune	end of July
Alhagipersarum	beginning ofJune	end of July
Mountain area		
Eremurus robustus	2 decade ofMay	end of June
Medicago tianschanica	beginning ofJune	1 decade ofAugust
Melilotus officinalis	from3decade of May	end ofJuly
Melilotus albus	end of May	1 decade ofJuly
Trifolium repens	end of May	2decade ofAugust
Hedysarumflavescens	end of May	1decade ofJuly
Lathyrus pratensis	2 decade ofJune	3 decade ofJuly

Ampelopsis argyrophylla	3 decade ofJune	2decade ofJuly
Epilobium hirsutum	2 decade ofJune	1decade ofJuly
Nepeta mariae	beginning ofJune	end ofJune
Nepetaalatavica	middle ofJune	end ofJuly
Betonica officinalis	beginning ofJune	middle of July
Salvia virgata	beginning ofJune	1 decade ofAugust
Melissa officinalis	beginning ofJune	middle ofAugust
Oriqanum tuttanthum	beginning ofJune	1 decade ofAugust
Echinops maracandicus	2 decade ofJuly	end of August

ture in this part of the nest can lead to disruption of the development processes of the brood or to its death.

At edge or called forage honeucomb, the temperature is lower and usually are from 28 ^{0}C or less. On hot days, it will be higher and can even reach critical levels, that is almost correspond to the ambient temperature. Bees in this area are less sensitive to the temperature regulation. Typically, the melting point of wax is 62–65 ^{0}C. As the temperature in the nest rises, the viscosity of the wax decreases, it becomes viscous, and if there is feed or brood in the cells, the cells become substantially deformed. Due to the increase of air temperature, honey viscosity in honeycombs decreases. It becomes less viscous.

If the heat affects bee colonies for a long period of time, not only brood and bees can die in their nests, honeycombs can be deformed, but also biochemical and physical changes can occur in the products produced by them (bee bread, honey, royal jelly and others).

Bee families respond differently to the rising of environmental temperatures. The maximum temperature that bees can withstand for a short time is 47-48 ^{0}C. It is in this temperature range that bees are treated from ticks using heat-chambers (Zharov, 2011). But in wild, bees have the ability to counteract to the heat. In the heat, bees can vent the nest, bring and evaporate water in the hive. In addition, in order to avoid overheating of honeycombs, some bees can leave the nest. Those that stay at the honeycombs, as a rule, reduce activity, thereby contributing to a decrease in heat production.

We found that given the conditions of the Fergana region of Uzbekistan, honey plants and bees are most exposed to high temperatures during the second half of summer. The species diversity of entomophilous plants of the Fergana Valley is analyzed. The most common plant species by areas of distribution are identified (table 2). Plants are grouped in each zone, subject to high temperatures during their flowering period.

If there is a large amount of nectar in the nests of families to the period of the starting of heat, then it will be easier for bees to resist rising of air temperatures for several days. Due to the evaporation of water and increased ventilation, they can reduce the temperature inside of the nest. In the non-breeding period, the bees activate the supply of water to lower the temperature.

Bees respond to an increase of ambient temperature as follows. Due to the fact that plants do not emit nectar, the bees reduce, and then completely stop flying. This usually becomes noticeable when the thermometer rises above 35 ^{0}C.

The number of flying bees from the total number in the family is approximately 70%. At the heat, the number of individuals in the nest increases by this amount. Heat and lack of honey collection increase the aggressiveness of bees.

To stabilize the temperature in the nest, the bees first activate ventilation, and then additionally evaporate the brought water (Fig. 1). But bees can also ventilate the nest during the period of honey collection, when excess moisture is removed from the nest, processing nectar into honey. In the heat, if such efforts of the bees do not give the necessary result, most of them leave the cells. They go outside the hive, where they concentrate in the notch zone, more often on the arrival board or under the bottom of the hive (Fig. 2).

We have identified the effects of heat on the flight activity of worker bees and their behavior. During the day, under the influence of high temperatures, the bees of the families did not show the same activity before departure. In the morning they actively took off. As the temperature increased, the number of departures decreased. At 30 °C and above the bees stopped flying. This often happened from 11 a.m. to 6 p.m. During this period, the aggressiveness of bees in the colonies increased. They more often visited drinking bowls and brought water. In addition, bees actively ventilated the nests. Some of them left the nest and hung on the walls of the hive. Under prolonged exposure to high temperatures, worker bees hung in clusters on the walls of the hive at night. This behavior of bees lasted until the temperature dropped to 28 °C and below.

Bees what are remaining in the hive, are caring for the brood and are ventilating the nest. This behavior of the bees justifies itself. When part of the bees leaves the hive, the space in the gaps of the honeycombs (streets) start to be free, which contributes to better ventilation of the nest.

If the hives have poor ventilation, are located in an open area, and not in the shade, the bee family is not always able to withstand high temperatures. Because of these conditions, bees most often die. In contrast, the insignificant effect of heat on bees often provokes swarming (Markov, 2007).

The nature is very sensitive to the effects of any negative factors. Plants and honey bees have adapted to certain conditions, they have developed protective functions to the action of negative factors over tens of millions of years. Unfortunately, a man's activity negatively affects the environment, flora and fauna. Under such conditions, honey bees will continue to be under the influence

Fig. 1. Bees actively ventilate the nest

Fig. 2. Bees left the hive to avoid overheating the nest

of these factors, the area of their distribution, number and the productivity of families will decrease.

Conclusion.

Ecological deterioration, global warming, reduction of land area which are occupied by entomophilous plants and other factors is a huge threat of extinction of honey bees. Given the importance of bees as a component of the biocenosis of wildlife, the threat of extinction of many species of plants and animals, including humanity, is increasing. By improving the ecology, deepening research related to the impact of negative factors on bees and plants, it can become possible to prevent existing threats.

Список літератури

1. Броварський, В. Д. Особливості постановки дослідів на окремих видах тварин. Методологія та організація наукових досліджень у тваринництві. К.: Державне видавництво «Аграрна наука». 2017. 328 с.
2. Броварський, В. Д., Бріндза, Ян, Папченко, О. В. Медоносні бджоли і навколишнє середовище. Збірник праць IX Міжнародної міждисциплінарної науково-практичної конференції «Сучасні аспекти збереження здоров'я людини». Ужгород. 2016. С.69-71.
3. Броварський, В. Д., Папченко, О. В. Кормові ресурси, розвиток і продуктивність бджолиних сімей. Вісник Житомирського національного агроекологічного університету (Науково-теоретичний збірник). 2014. Том 23. №2 (44). С.155-158.
4. Гайнов, Ю. В. Жара, пожары и пчелы...Пчеловодство №6. 2011. С.41.
5. Жаров, В. Г. Нюансы термообработки ноябрь. Пчеловодство №9, 2011.
6. Марков, В. И. Рост и развитие пчелиной семьи в течение года. Пчеловодство. 2007.№ 9. С. 10-12.
7. Пашаян, С. А., Маквецян, А. Г. Адаптация пчел итальянской породы в Калифорнии. Пчеловодство.2019. №7.

8. Поліщук, В. П., Гайдар, В. А., Корбут, О. В. Пасіка. Київ: ТОВ ВПК «ОБНОВА», 2012. С.96-110.
9. Пчеловодство Австралии страдает от аномальной жары. Мир пчеловодства. 2014. https://www.apiworld.ru/1390898476.html
10. Таранов, Г. Ф. Биология пчелиной семьи. М.: Государственное издательство сельскохозяйственной литературы. 1961. 332с.
11. Hussein, M. H. Beekeeping in Arab Countries. Assiut University, Assiut, Egypt. 2012. 628 p.
12. Perry, C. J.,Sivik, E., Myerscough, M. R., Barron, A. B. Rapid behavioral maturation accelerates failure of stressed honey bee colonies. Proc Natl Acad Sci U S A. – 2015 Mar 17; 112(11): 3427-32.

References

1. Brovarsky, V. D. (2017). Features of experiments on certain species of animals", item "Experiments on bees. Methodology and organization of scientific research in animal husbandry. Kyiv. State Publishing House "Agrarian Science" NAAN. 328. (in Ukrainian)
2. Brovarsky, V. D., Brindza, J., Papchenko, O. V. (2016). Honey bees and the environment. Proceedings of the IX International Interdisciplinary Scientific and Practical Conference "Modern Aspects of Human Health". Uzhhorod. 69-71.
3. Brovarsky, V. D., Papchenko, O. V. (2014). Feed resources, development and productivity of bee colonies. Bulletin of Zhytomyr National Agroecological University (Scientific and Theoretical Collection). 23(2/44). 155-158.
4. Gainov, Yu. V. (2011). Heat, fires and bees... Beekeeping. 6.41.
5. Zharov, V. G. (2011). Nuances of heat treatment November. Beekeeping. 9.
6. Markov, V. I. (2007). Growth and development of the bee family during the year. Beekeeping. 9. 10-12.
7. Pashayan, S. A., Makvetsyan, A. G. (2019). Adaptation of bees of the Italian breed in California. Beekeeping. 7.
8. Polishchuk, V. P., Haydar, V. A., Korbut, O. V. (2012). Pasika. Kyiv. TOV VPK «OBNOVA». 96-110.
9. Beekeeping in Australia suffers from abnormal heat (2014) World of beekeeping. https://www.apiworld.ru/1390898476.html
10. Taranov, G. F. (1961). Biology of the bee colony. Moscow. State Publishing House of Agricultural Literature. 332.
11. Hussein M.H. (2012) Beekeeping in Arab Countries. Assiut University. Assiut. Egypt. 628.
12. Perry, C. J., Sivik, E., Myerscough, M. R., Barron, A. B. (2015). Rapid behavioral maturation accelerates failure of stressed honey bee colonies. Proc Natl Acad Sci U S A. 112(11). 3427-32.

В. Д. Броварський, А.Т. Турдалієв, Г. І. Мірзахмедова (2020).
ВИСОКІ ТЕМПЕРАТУРИ ТА ЇХ ВПЛИВ НА РОСЛИНИ І БДЖІЛ. ANIMAL SCIENCE AND FOOD TECHNOLOGY, 11(2): 5-15. https://doi.org/10.31548/animal2020.02.005.

Анотація. *Здійснено аналіз впливу високих температур навколишнього середовища на ентомофільні рослини і медоносних бджіл. Дослідження видового складу ентомофільних рослин, строків їх цвітіння, піків температур впродовж літа здійснено в умовах Ферганської області Узбекистану. Етологічну поведінку бджіл за високих температур вивчено на Голосіївській навчально-дослідній пасіці НУБіП України. У дослідах застосовано загальноприйняті методики дослідження бджіл. За результатами досліджень визначено максимальні температури навколишнього середовища в околицях м. Фергана. Встановлено, що з урахуванням умов Ферганській області Узбекистану, найбільш вразливі через вплив високих температур медоносні рослини і бджоли в період другої половини літа. Проаналізовано видове різноманіття ентомофільних рослин Ферганської долини. Встановлено найбільш поширені види рослин за зонами їх розповсюдження. Згруповано*

рослини по кожній зоні, що підлягають впливу високих температур на період їх цвітіння. Визначено наслідки впливу спеки на льотну діяльність робочих бджіл і їх поведінку. Впродовж дня, за дії високих температур, бджоли сімей проявляли не однакову активність до вильотів. Вранці вони активно вилітали. Із зростанням температури кількість вильотів зменшувалась. За 30 °С і вище бджоли припиняли літати. Часто це відбувалось з 11 години ранку до 18 вечора. В цей період агресивність бджіл у колоніях зростала. Вони частіше відвідували поїлки і приносили воду. Крім того, бджоли активно вентилювали гнізда. Частина їх покидала гніздо і звисала на стінках вулика. За тривалої дії високих температур робочі бджоли висіли у вигляді грон на стінках вулика й у нічні години. Така поведінка бджіл тривала до моменту зниження температури до рівня 28 °С і нижче. З огляду на негативний вплив глобального потепління на флору і фауну, важливість медоносних бджіл як складової біоценозу живої природи, зростає ймовірність зникнення на землі багатьох видів рослин і тварин. Зроблено висновок про необхідність поліпшення екології, поглиблення досліджень пов'язаних з питаннями впливу високих температур на медоносних бджіл і ентомофільні рослини.

Ключові слова: *температура повітря навколишнього середовища, медоносні рослини, медоносні бджоли.*