типу стрессоустойчивости коров распределили на три группы: высокой стрессоустойчивости – те, у которых не происходило, или отмечалось незначительное условно-рефлекторное торможение молокоотделения; средней стрессоустойчивости – в которых произошло до 66,7 % условно- и до 33,3 % доений безусловно-рефлекторное торможение динамики молокоотделения, и низкой стрессоустойчивости – у которых больше 66,7 % произошло условно- и более 33,3 % безусловно-рефлекторное торможение.

Установлено, что высокострессоустойчивые животные характеризуются высокой адаптационной пластичностью к действию стресс-факторов и способностью сохранять стабильную продуктивность. Продуктивность коров со средней стрессоустойчивостью снизилась на 2,17 кг (или 8,49 %), на фоне стабильности надоев высокострессоустойчивых коров, а низкострессоустойчивых – на 5,68 кг (или 22,54 %). Высокострессоустойчивые коровы занимают доминирующие позиции в ранговой иерархии стада, чаще посещают доильные установки и кормовую станцию, потребляют больше концентрированного корма, быстрее адаптируются к условиям доения по сравнению с коровами средней и низкой стрессоустойчивости.

Ключевые слова: стресс, адаптация, роботизированное доение, иерархия, молочная продуктивность, кормовая станция.

Productivity of cows of different tolerance to stress under robotized milking conditions

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This article demonstrates the results of studies dealing with the influence of fresh cow tolerance to stress on the productivity, ethological, and hierarchical characteristics under conditions of voluntary robotized milking.

The research was carried out in Terezine robotic dairy farm on the first calve cows of the Ukrainian black-and-white breed (n = 50) during 2nd-3rd month of lactation. At the same time, according to the type of stress resistance, the cows were divided into three groups: high stress resistant – those that did not have or had insignificant conditioned reflectory inhibition of milk production; the medium stress resistant – in which up to 66.7 % of the conditional inhibition of milk production and up to 33.3 % of unconditional inhibition of milk production was observed and low stress resistant – in which more than 66.7 % had conditioned and more than 33.3% unconditioned reflectory inhibition.

It has been researched that lactating cows with high tolerance to stress are characterized by high adaptive plasticity to the stressors and the ability to maintain stable milk productivity. The productivity of cows with moderate resistance to stress has decreased by 2.17 kg (or 8.49 %), against the background of the milk-yield stability of cows with high tolerance to stress and cows with low tolerance to stress by 5.68 kg (or 22.54 %). The cows with high resistance to stress occupy the dominant positions in the rank hierarchy of the herd. More often they visit the milking machine and feed station, consume more concentrated feed, and adapt more quickly to the conditions of milking than cows with moderate and low resistance to stress.

Key words: stress, adaptation, robotized milking, hierarchy, milk productivity, feed station.

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BEE STIMULATION TO FORM PROTEIN FOOD RESERVES

Досліджено різні способи стимуляції бджіл до закладання білкового корму при використанні штучних стільників. Доведено, що використання штучного стільника для отримання перги, за умови додаткової обробки його елементів воском і медовою ситою, не стимулює бджіл до закладки та переробки в осередках білкового корму. Визначено, що при безпосередній участі робочих бджіл у формуванні запасів перги, мало місце найбільше споживання білкового корму. Це вказує, що робочі бджоли використовують для власних потреб свіжопринесену обніжку в період її активної заготовки. Встановлено, що ефективним способом стимуляції бджіл до переробки обніжки в пергу є разове ущільнення її в штучних стільниках з подальшою обробкою верхнього шару корму медом. Такий спосіб стимулює бджіл до формування запасів перги і знижує їх активність використання білкового корму з осередків штучних стільників. Імовірно, що обробка ущільненої обніжки медом пригнічує у бджіл потребу використовувати білковий корм, переорієнтовуючи їх із заповнених осередків на інші стільники гнізда родини, де є ділянки, на яких сконцентровані запаси перги.

Ключові слова: етологія бджіл, бджолина обніжка, перга, штучний стільник, секції стільника, робочі бджоли, осередки, бджолині сім'ї, стимуляція.

Formulation of the problem. By industrially maintaining bee-keeping, bee-keepers get not only honey from the bee colonies, but other goods as well. It widens the range of apicultural products in the market and promotes enterprises' rise in profitability. At the same time, despite the increasing needs for separate kinds of apicultural goods, bee-breadin particular, their overall production level is very

slight because of the lack of modern and effective technologies and equipment. So, in order to get bee-bread, bee-keepers use methods that are based on the destruction of wax combs. [11, 12, 14]. Nowadays in order to get bee-bread, honey combs made of artificial materials have been designed [1, 2, 6, 9, 13]; the overall study of the morphology of the pellets, biochemical composition and microbiology of this variety of the producthave been also conducted [3-5, 7, 17-20]. However, bees unwillingly domesticate the cellsofsuch honeycombs, and the ways of regulating the processes of forming protein food reserves in them haven't been designed at all. That is why the investigation of the behavior of bees and working out the ways of stimulating bee colonies to laying protein food are of vital importance from theoretical as well as practical point of view.

Analysis of the latest researches and publications. In order to decrease the pressureof involving the bees intowax building activity, avoid problems of damaging frames (transporting beecolonies, pumpingouthoney, etc), cut costs on buying empty honey combs, effectively use biological potential of bee colonies while getting different kind of goods and improve their quality, prevent affection and spread of diseases, artificial materials for producing honey combs are widely implemented nowadays. Among them are nest honey combs, plastic empty honey combs, plastic honey cells, honey combs for getting even-aged brood in artificial raising of queen bees, balls of queen-bee cells made of polymer materials etc. [4, 8]. In order to make bees domesticate artificial honeycomb sorcells (ballsofqueen-beecells,Dombrovskyii honeycombs), different ways of active ating this process sareused (reducing the number of nests, processing the elements orcells of honeycombs by wax or carbohydrates etc) [1, 2, 7]. Nowadays, because of the lack of knowledge of honey bees biology, there is a need for doing researches on stimulating bee families to domesticate artificial honey combs or their separate elements and design manufacturing technology of apicultural goods on their basis, bee-bread in particular. We have put emphasis on this particular problem in our investigations.

The **aim** and the task of the research is to investigate ethnology of bees by different ways of stimulating them to form protein food reserves in artificial honey combs.

According to the set aim, the following things had to be done:

•Define the effectiveness of laying bee bread by bees using different ways of preparing containers of artificial honey combs;

• Research the intensity of forming prote in food reserve su sing different ways of stimula ting bees.

Materials and methods. Taking into account the peculiarity of bees'reaction on non-natural materials for them, wehavetosolve 2 problems, namelyencouragebeestodomesticatetheartificialhoneycombandmakethemconcentrateprotein feed in its cells. In order to do the research, we have used several ways of attracting bees to domesticate cells. The first one dealt with the preparation of the containers themselves. Thus, to control the process we have used the artificial honey combs without any previous preparation. Having joined the details (containers, middle wall, frieze rail) we have put them into the nest of bee colonies between the feeding and brood parts. During the whole period of the investigation we have daily examined and identified the number of cells in the containers that are filled with bee bread.

In other cases the cells with honey combs have been processed. In research group 1 the honey combs have been processed by wax. In order to do this, the containers have been put into the melted wax for a few seconds, and then honey combs have been formed out of them and have been put into the nests of bee colonies into the same areas of nests as in the test group. In research group 2 artificial honey combs, except the ones that have been processed by wax, have been irrigated by honey syrup. Having installed honey combs into the nests of bee colonies, the records have been done in the same way as in the test group.

The next type of the reaction of bees on laying protein feed was encouraging them to concentrate on making bee bread pellets by means of attracting workers by putting pollen pellet directly into the cells of containers of the artificial honey comb. We have used 4 methods in these investigations. They had one thing in common. Artificial honey combs couldn't be processed by wax. We have manually put 3-5 pollen pellets into their cells. The thing that made these methods different was the fact that the dry pollen pellet has been put into the cells of honey combs (group 3), having filled up 3-4 dried pollen pellets, the cells have been irrigated by honey syrup and their content has been trampled down using the thickener we have designed (research group 4). In group 5 freshly harvested pollen pellet has been put into the cells, in group 6 it has been additionally thickened, but it hasn't been processed by honey syrup as in research group 4.

In research groups 3–6 during daily inspection of artificial honey combs and the record of cells filled with protein food they appeared to be empty. The bees were shaken out of the honey combs and 3–5 pollen pellets were put into empty cells according to the investigation methods. All in all, this procedure has been done 4 times. Five honey bee colonies have been involved in these groups. These colonies have been chosen according to prototypes. [3]. The results of the records have been analyzed after the mathematical processing.

Results of the research. In order to stimulate honey bee colonies to store up protein food, lots of work has been done to form their nests. In every group we have chosen honey combs from every bee family. These honey combs contain lots of cells filled with bee bread. Taking into account the fact that bees mostly consume bee bread while feeding slugs, we have chosen one honey comb with sealed brood out of the nests. Instead of them we have put the ones with unsealed brood. The honey combs with sealed brood have been moved into the nests of bee colonies of the user group. The frames with slugs for experimental bee colonies have been chosen from them as well. According to our plan, the protein food deficit and a great number of unsealed brood had to stimulate the bees to activate the process of collecting pollen.

According to the results of undertaken studies, the following things have been determined and brought to light (Table 1). In the methods that used only the preparation of artificial honey combs (test group and research group 1,2) the bees passively domesticated the cells of the containers. The bees in test group started to lay protein food into single cells only 4 days after the nests of the artificial honey combs have been installed. During the 4th record the bees of the test group have involved only 0,004 % of containers of the artificial honey combs out of 5496 available for bee bread. Besides that, in the cells of the artificial honey combs the bees didn't grow brood and didn't create the reserves of carbohydrates.

Table 1 – **The effectiveness of putting the protein food by working bees under various conditions of preparation of artificial combs,** n=5

The way of comb preparation	Domesticated cells among 5496 in the comb							
	The quantity of iterations							
	I		II		III		IV	
	M±m	%	M±m	%	M±m	%	M±m	%
Without processing the cell (control)	–	–	–	–	–	–	0,2±0,2	0,004
The cells processed with wax (experiment 1)	–	–	0,2±0,20	0,004	0,8±0,58	0,015	0,2±0,20	0,004
The cells processed with wax and honey syrup (experiment 2)	–	–	1,2±0,58	0,022	1,4±0,60*	0,025	1,8±0,37**	0,033
In every iteration the empty cells were filled with pollen pellet								
3-4 dried pollen pellet is put into cells (experiment 3)	0,4± 0,24	0,007	2,2± 0,58**	0,400	4,4± 0,93***	0,080	10,8± 2,15**	0,197
3-4 dried pollen pellet is put into cells processed with honey syrup and thickened(experiment 4)	11,0± 2,00***	0,200	17,0± 2,43***	0,309	54,2± 7,66***	0,986	52,2± 8,02***	0,950
3–4 newly collected pollen pellet is put into cells (experiment 5)	24,0± 3,61***	0,437	100,0± 4,64****	1,820	194,6± 25,76***	3,540	239,2± 24,36****	4,352
3–4 freshly collected pollen pellet is put into cells and thickened (experiment 6)	617,0± 37,87****	11,226	636,6± 36,74****	11,583	976,6± 58,67****	17,769	4492,6± 362,02****	81,743

Notes: *p<0,1; **p<0,02; ***p<0,01; ****p<0,001 in compare with control group

The resultst hawe got, having tested the artificial honeycomb in the testgroup,indicate that bees passively domes ticat ecellsin the section sandit's impossibl etouse the artificial honeycomb effect ively witho utinvolving the additional stimulation.

The results of testing artificial honey combs in bee colonies of the research groups 1 and 2 haven't been encouraging. During the first record in research group 1, in which honey combs have been processed by wax, as well as in group 2, in which the cells have been processed by wax and honey syrup,

the bees have not involves either of the cells to store food. In a day (record 2) we have seen the presence of protein food in separate cells of artificial honey combs of research bee colonies 1 and 2. During the next two records the intensity of forming protein reserves in these groups was almost of the same level. The bees of these colonies have involved the additional space for laying pollen pellet, but it referred only to at least 10 cells which constituted 0,004 and 0,003 % from their overall amount of the honey comb. It was noticed that in the process of forming bee bread reserves the bees not only filled the cells of the honey comb with pollen pellet, but also took food out of them.

Thus, using the artificial combs for making bee bread, even with extra processing of its elements with wax and honey syrup, does not encourage bees to laying and processing protein food in cells.

The research of the ethology of bees with the help of different methods of putting dry and freshly harvested bee pollen pellet have been very encouraging. We have used dried pollen pellet in researches 3 and 4.

As it appeared to be, the bees in the bee family in the 3rd research group passively reacted to filling the cells with pollen pellet. The percentage of the cells filled with bee bread, regarding their overall amount on the artificial honey combs, was from 0,007 to 0,4 %, on the condition that we refilled empty honey combs with pollen pellet daily. Even when we processed pollen pellet with honey syrup (research 4) and thickened them, the bees insignificantly activated the process of laying the bee bread into the cells of artificial honey combs. Using this method we have identified a slight increase in the number of cells with bee bread located on artificial honey combs – 0.2-1 %. It is important to underline that the bees enlarged the space for bee bread in these honey combs with every following fill-up of the empty cells with pollen pellet. If to compare these results with the test group, the activity of bee families of this group in laying protein food was much higher.

Thus, the use of dry pollen pellet on the condition that it's put into the box of artificial honey combs in small amounts doesn't stimulate bees to lay the bee bread intensively, even if the thickening and the processing of the food by honey syrup is done 4 times.

A completely different reaction of bees on laying the bee bread reserves took place when freshly harvested pollen pellet was used. In research group 5 the bees enlarged the space for forming protein food reserves despite the fact that 3 – 5 pollen pellets were put into the cells of artificial honey combs without being thickened. At the same time, if to look at the total amount of the cells of honey combs in terms of quantity, these results would be still minor, but a sequence higher than in research 4 and in other previous groups of bee colonies. For example, after the first fill-in of the fresh pollen pellet, the bees have put bee bread into the cells on the area that exceeded research group 4 2,2 times. During the second record the differences between these groups were 5,9 times, during the 3rd record – 3.6, the 4th – 4.6 times. If to compare it with the test group, the difference in data was highly probable ($P<0,01$; $P<0,001$). It is possible that the freshly harvested pollen pellet is more preferable for bees to thicken it in the cells, because it contains plenty of water in it. Taking into account the results of these investigations, it can be inferred that the first thing that attracts bees to lay protein food reserves is, first of all, the quality of pollen pellet. And the processing of the constitutive elements of the artificial honey combs doesn't reinforce the bees' instinct of reprocessing the pollen into bee bread in cells. Besides that, as the bees use only fresh pollen pellet to stock bee bread, it is the most attractive thing for them to process protein food, unlike the dried pellets. It is not improbable that the dry pollen can be more difficult to yield to fermentation after ripening of bee bread. We think that these processes have to be thoroughly researched with the help of up-to-date biochemical, microbiological, physical and other methods.

The most encouraging results were received in the 6th research group. Inthisgroupafter 3-5 pollen pellet shave been put into the cell sand thickened, the artificial honeycombs were moved to the nests of bee colon iessothat they could form protein food reserves. The research show edt hat during the first record the bees started toprepare the reserves of beeb readin 11.2 % of cellsof their total amount in the honeycombs. Compared to the research 5, the bees of this group have enlarged the space for reprocessing pollen pellet into bee bread in honey combs by 25.7 times.

After the next filling of the empty cells the bees of this group slowed down the pace of forming protein food reserves. The number of cells with bee bread after the second record has increased by 3,2 %. During the 3rd record the number of cells filled with bee bread in the artificial combs exceeded the area of section 4. After the cells have been filled with pollen pellet for the 4th time, the percentage of laying bee bread by workers was 81,7 %.

The bees mainly laid the bee bread reserves starting from the bottom sections of the artificial honey comb located closer to the back wall of the beehive. Besides that, the bees domesticated the cells and laid the bee bread better on those sides of the artificial honey combs which were oriented to the central part of the nests of honey bee colonies, namely to the hive entrance block. The cells, which the bees laid bee bread into, could be identified according to several features. Examining the honey combs in the cells, we found freshly harvested pollen pellet. The bees often dipped into themand the shiny spew appeared on the surface of protein food where the process of forming the pellets of the bee bread was finished.

In the process of forming protein food reserves the bees managed not only to store bee bread but also consumed it even from those cells in which the upper layer of the pollen the bees processed by honey. However, the bees mostly consumed the protein food for the needs of their colonies from those cells which haven’t been filled up with pollen pellet completely. As a rule, the bees didn’t consume the bee bread from the central sections and they ate bee bread in small amounts from the peripheral zones.

So, the workers on the artificial honeycombs in ordert ostore protein food actively start to domesticate those cells which contain the first portions of the thickened freshly harvested pollen pellet. Processing of the cells by wax or honey syrup doesn’t stimulate the bees to domesticate artificial honey combs.

The sections of artificial honey combs that were located closer to the back wall of beehive were mostly the area for storing protein food. The bees gradually domesticate all the cells of the artificial honey combs to process pollen pellet into bee bread. In order to make the bees lay and thicken pollen pelle titis necessary to fill the empty cells with freshly harvested pellets and thicken the mnot less than 4 times a day. It is not appropriate toused ried pollen pellet to stimulate the bee stolaybee bread into the cells of artificial honeycombs. The bees mostly take dried pellet out of the cells and unwillingly lay protein food reserves into them.

Taking into account that the most effective way of stimulating bees to store bee bread on artificial honey comb is the method of thickening of 3-5 pellets of freshly chosen pollen pellet in the cells, it was used in further researches. Besides that we were interested in researching the question of bees’ reaction to protein food if 2/3rd of the cells were filled with freshly harvested pollen pellet.

While researching the ethnology of bee sthat laid prote in food it was fo und that they didn’t break pellets into pieces in the process of thickening pollen pellet. Thus, they don’t add ferments into them. That is why we have decided to do additional researches with the help of artificial honey combs. We have used two more methods in our research, except the method of stimulating bees, to store protein food by trampling down a small number of pollen pellet (test group). The first method was a single thickening of pollen pellet up to 2/3rd of the cells height without processing it (research 1). The second method included the processing of upper layer by honey (research 2). These ways of getting bee bread by using artificial honey combs checked the method of stimulating the bees to store protein food by thickening a small amount of freshly harvested pollen pellet in the cells and the process has been repeated 4 times after that. To do this research wehaveused 3 bee coloniese ach of which had 5 bees. The honey combs in the nest were placed in the same area as in the previous research. During this research we have recorded the number of cells with bee bread and identified the total weight of the pollen pellet we’ve got after the honey combs have been in the nests of bee colo-nies for 2 weeks. The data received during these researches can be found in Table 2.

According to the intensity of laying protein food reserves into artificial honeycombs using different ways of stimulating bees to process pollen pelletin to beeb read, it has been identified that the bee colonies of the test and research roup 1 and 2 had different level of activity while doing this jobs. The common thing in the behavior of the bees in all the bee family groups was the thing that while laying bee bread and in the process of finishing its forming, the bees consumed protein food in small amounts. You could see that when the bees have finished processing upper levels of protein food by honey and started eating unripe bee bread the next day. The bees mostly consumed food from the cells of those sections which were located at the bottom or at the sides of artificial honey combs. The bees did not consume bee bread on the central sections of the honey combs.

After 2 weeks lots of sections that were located on the peripheral sides of artificial honey combs had cells with a small amount of bee bread in them, and there were also the ones that appeared to be empty. The intensity of consuming the protein food by bee colonies that belong to one and the same group was different. The bees of some colonies consumed less bee bread and some of them consumed more. The reason for such behavior of bees could not be identified. We have to investigate these pro-

cesses more thoroughly in order to solve this problem. It can be inferred that the intensity of consuming protein food depends on different factors. First of all, it refers to the age of bee workers, their physiological state, the type and the amount of work that has to be done, the quantity of unsealed brood in the nests of bee colonies, etc.

Table 2 – **The effectiveness of different methods of getting bee bread with the help of artificial honey comb,** n=5

Index	The ways of getting bee bread					
	Test (stimulation of bees to laying bee bread by thickening small portion of pollen pellet)		Research 1 (single thickening of freshly harvested pollen pellet of 2/3 of the cells)		Research 2 (single thickening of freshly harvested pollen pellet of 2/3 of the cells and processing their surface with honey)	
	The number of cells filled with bee bread, item	The amount of bee bread received from one honey comb g	The number of cells filled with bee bread, item.	The amount of bee bread received from one honey comb g	The number of cells filled with bee bread, item	The amount of bee bread received from one honey comb g
M±m	4400,2± 371,06	706,6± 163,56	4750,2± 227,44	1135,2± 159,28	4886,4± 219,30	1368,7± 108,70*
Lim	3162–5139	278,19–1205,06	4181–5255	711,82–1618,54	4274–5357	1073,54– 1687,46
Cv, %	18,86	51,76	10,71	31,38	10,04	17,76

Note: * P<0,05 compared to the test group

It has been proved that the bees of test and research groups used different number of cells in artificial honeycombs to process pollen pellet into bee bread depending on the ways of stimulating bees to store protein food. Thus, at the end of the experiment, i.e. 14 days after the protein food reserves have been stored, we have found that 80,1 % of the cell sonartificial honeycombs were completely or partially filled by bee bread. Co-boundary data (Lim) of this group were between 3162 and 5139 cells. The in putof protein food that varied according to the intensity of the process in fluenc ed hev ariati on index, which was 18,9 % in this group, tha tshows the in stability of thi index because of the influence of different factors. In general,taking into account the fact that the bees have partially consumed protein food in the cells, single extraction of bee brea in terms of one artificial honey combin this group was 706,6 g., with the minimum of 278,2, and maximum one 1205,1 g (Lim), whereas the variation index was 51,76 %. It's necessary to mention that this group, in which the bee workers didn't actually take part in storing bee bread, protein food was consumed to the biggest extend. This indicates that bee work ersus efreshly harve sted pollen pelletfor the irow nneedsat the time when it is actively produced. In order to decide which the most attractive food for the bee family is (pollen pellet or bee bread), we have to thoroughly investigate the behavior and nutrition of bees.

In the first resea rchgroup, where asingle thic kening of the arti ficial honeycombs section cells with fres hly harves ted pollen pelletwa sused, alongside with the processing of bee bread, the bees consumed protein food in small amounts. This process was less active than in the test group, though. During the two weeks that were spent on keeping artificial honey combs of bee colonies 86,4 % of section cells were filled with bee bread. If to compare this method with the test group, the bees involved 7,9 % cells more for storing bee bread. Because of the fact that the bees were less active in consuming protein food from section cells, the amount of bee bread we got from one artificial honey comb was 1135,2 g on average, which is 60,6 % more than in the test group. However, if to calculate the number of cells involved and the amount of bee bread received, the difference between the test and the first research group was improbable (P>0,1).

While thicke ningpo llenpellet in the cells of artificial honeycomb swith process sing food by honey (research 2) the bees work edon storing beeb read morea ctively. In this group the percentage of the cells filled with bee bread was almost 90 %.Unliket hetes tgroup, the bees of the colonies of research group 2 used 11% more cells for storing protein food whereas in the research group 1 the percentage was 2.9 %. However, alongside with this, the consumption of protein food in this group was minimum, unlike in the methods previously used. This influenced the average amount of the bee bread received in terms of one artificial honey comb. Thus, according to the results of the records we got out of each artificial honey comb, we got 1368, 7 g in research group 2, which is 93,7 % more than in the

test group (P<0,05) and was 20,6 % higher than the index of research group 1 (the difference is improbable, P>0,1). In resear chgroup 2 theco-boundary data wereless(according to the number of the cells filled with bee bread as well as with the total amount of the pollen pellet received (Lim)) if to compare ot herme thods of preparing prote in food to the processes of conservation.

Conclusions. So, the most effective way of stimulating bees to process pollen pellet into bee bread is its single thickening in artificial honey combs with the following processing of the upper layer of food with honey. Such method encourages the bees to form bee bread reserves and lessens their activity of consuming protein food from the cells of artificial honey combs. It is likely that the processing of the thickened pollen pellet with honey oppresses the bees’ necessity to consume protein food from the filled cells and redirects them to other honey combs of the bee family nest which has areas filled with bee bread reserves.

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