

THE MORPHO-PRODUCTIVE PARTICULARITIES OF QUEENS *APIS MELLIFERA CARPATICA* INSEMINATED INSTRUMENTALLY

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Abstract

The aim of the present research was to reveal, in special experiments, the morpho-productive advantages and disadvantages of instrumentally inseminated queens, compared to their contemporaries naturally paired in nuptial flight. Two scientific experiments were carried out at the experimental apiary of the Institute of Zoology of the Academy of Sciences of Moldova (ASM), on two similar batches of bee colonies with instrumentally inseminated and naturally mated queens, of *Apis mellifera Carpatica* race, maintained in similar conditions feeding and maintenance. The results of the research showed that the instrumental insemination of queens is an innovative and efficient technological method for increasing the productivity of bee families, increasing production volumes and raising the economic efficiency of the beekeeping branch. Instrumentally inseminated queens have a higher prolificacy, compared to their contemporaries naturally mated in the nuptial flight, with 164 eggs/24 hours, or 10.0% ($t_d = 6.1$; $P < 0.001$). Working bees from the families of instrumentally inseminated queens had a higher development of external morphometric indices, compared to their contemporaries from the families of queens naturally mated in nuptial flight, such as humus at: horn length - 0.19 mm, or 2.9% ($t_d = 6.71$; $P < 0.001$), the ulnar index of the anterior right wing - by 4.3 absolute units, or by 10.2% ($t_d = 5.00$; $P < 0.001$) and the share of bees with positive discoidal dislocation - by 11.0 absolute units, or by 15.4% ($t_d = 3.10$; $P < 0.01$). The bee families of the instrumentally inseminated queens had a significantly higher development of the level of morpho-productive characters, compared to their contemporaries of the queens naturally mated in the nuptial flight, as follows: colony power - by 0.17 kg, or by 6.5% ($t_d = 6.07$; $P < 0.001$), disease resistance - by 3.4 absolute units, or by 4.1% ($t_d = 3.15$; $P < 0.01$), viability of the seedling - by 4.0 absolute units, or by 4.7% ($t_d = 3.70$; $P < 0.001$) and honey production - by 8.39 kg, or by 19.9% ($t_d = 5.31$; $P < 0.001$). Bee families of queen-daughters obtained from instrumentally inseminated mother-queens possess a higher genetic potential for productivity than their contemporaries of queen-daughters obtained from mother-queens naturally mated in nuptial flight, as follows: colony power - by 0.12 kg, or by 4.2% ($t_d = 2.26$; $P < 0.05$), disease resistance - by 1.8 absolute units, or by 2.0% ($t_d = 2.50$; $P < 0.05$), viability of the brood - by 1.9 absolute units, or by 2.1% ($t_d = 2.84$; $P < 0.01$) and in honey production - by 5.30 kg, or with 12.6% ($t_d = 3.01$; $P < 0.01$). In the following winter, bee families of queen-daughters obtained from instrumentally inseminated mother-queens had a higher wintering capacity (winter hardness) than their contemporaries of queen-daughters obtained from mother-queens naturally paired in nuptial flight, by 4.0 absolute units, or by 5.0% ($t_d = 2.25$; $P < 0.05$).

Key words: *Apis mellifera Carpatica*, instrumental insemination, natural mating, queens.

INTRODUCTION

In the Republic of Moldova is approved for breeding the local race of bees *Apis mellifera Carpatica*, which has a number of valuable morpho-productive biological properties, such as: good adaptation to specific pedo-climatic environmental conditions, increased resistance to wintering and disease, mildness, the increased prolificacy of queens and high skills of accumulating bee production in the nest. The clandestine crossbreeding of this local race leads to negative consequences, such as genetic segregation of the race and the result of crossbreeds with undesirable traits (aggressive,

not adapted to local conditions) and low productivity (Siceanu et al., 2002).

For these reasons, according to the National Program for Genetic Conservation and Breeding of the Local Bee Population in the Republic of Moldova, their selection is recommended to be carried out by the method of purerace breeding (Cebotari, 2006).

In animal husbandry, the system of breeding purerace animals provides for the application of a series of methods of selection, over several generations, of individuals required by the performance of one or more characters, as well as of directed mating (nominal or in the group) in order to obtain a predicted (desired)

descendants, with certain specific morpho-productive properties.

In beekeeping, the application of these methods and selection procedures is quite difficult. The main obstacle in the progress of genetic breeding of *Apis mellifera* bee populations is the queen's biological reproductive particularities, characterized by her mating with drones in flight, in open air, in the so-called "nuptial flight" or "mating flight", at a considerable distance from the apiary - in special places for gathering drones. The queen, in this flight, has the instinct of polyandry, expressed by mating with several males, thus filling the spermatocyst (spermatheca) with the mixed sperm of several drones of unknown origin. These biological features make it quite difficult to manage the process of mating queens with drones.

In this regard, beekeepers, breeders, for centuries have constantly sought methods to control the mating of queens with drones in order to manage selection, to obtain predictable descendants in the new generation with improved heredity (genetic potential for increased productivity).

Currently, a number of methods are known in beekeeping that allow beekeepers-breeders to carry out the somewhat paired pairing of queens. Among the most common of these are: intensive growth of drones in selected paternal bee colonies and prevention (non-admission) of their growth in all other colonies in the apiary (creation of a "drone barrier"); the double and total change of the queens in the apiary during two consecutive years; isolation of breeders during flight time (evening mating of queens with drones from selected families); isolation of drones in space (organization of breeding points in certain areas of isolated territories); instrumental insemination of queens (Билаш & Кривцов, 1991).

The latter method is the most accurate way to control the pairing of queens with drones of known origin and the most effective method of applying individual zootechnics selection in practice. The instrumental insemination of queens guarantees the knowledge (one hundred percent) of the genealogical origin of the offspring, ensures the possibility of obtaining descendants with a certain predicted heredity

and a genetic potential of increased productivity, which makes it possible to increase the selection effect in the new generation.

At the same time, the opinions of beekeepers and researchers in this field, about the influence of instrumental insemination on the quality of queens and the productivity of bee colonies, continue to differ in three groups.

However, most authors, representing the first group (Roberts, 1946; Руттнер, 1975; Woyke, 1976; Wilde, 1987; Бородачев et al., 1987; Билаш & Кривцов, 1991; Boigenzahn et al., 1993; Szalai, 1995; Cermak, 2004; Cobey, 2007; Cebotari, 2013), considers that the instrumental insemination of queens has a beneficial effect on the growth and development of the brood, on the honey productivity of bee colonies, as well as on the longevity of queens.

According to the reports of the researchers of the second group (Cobey, 1998; Gerula, 1999; Konopaska, 1987; Laidlaw, 1992; Nelson, Laidlaw, 1988; Pritsch & Bienefeld, 2002; Vesely, 1984; Карасев, 2011), instrumentally inseminated queens, in practice, do not differ in their qualities from contemporaries naturally paired in the "nuptial flight", therefore, they do not cause any differences in the development of morphic-productive features of bee colonies.

In the opinion of other authors (Harbo & Szabo, 1984; Мукимов, 2002), instrumentally inseminated queens possess some phenotypic deficiencies such as: smaller brood, shorter lifespan, bees accept them more difficult, efficiency Instrumental insemination is low because the technical insemination procedure does not approach the physiological act of natural mating, as a result, their families possess a lower honey productivity. These deficiencies overshadow, to some extent, the advantages of the progressive method of reproduction (instrumental insemination) in beekeeping.

In this sense, the purpose of the present research was to reveal, in special experiments, the morpho-productive advantages and disadvantages of instrumentally inseminated queens, compared to their contemporaries naturally paired in the "nuptial flight".

MATERIALS AND METHODS

To solve the proposed goal, two scientific experiments were organized and conducted at the experimental apiary of the Institute of Zoology of the Academy of Sciences of Moldova (ASM), on two similar groups of bee colonies with instrumentally inseminated and naturally paired queens of *Apis mellifera Carpatica*, maintained in similar conditions of feeding and care. The apiary was placed permanently (stationary) at the edge of a forest of broadleaf trees. The main sources of nectar and pollen in the apiary area were white acacia, lime and polyfloral vegetation.

The first experiment was conducted on two groups of bee families supplemented by young queens of the same age and with similar genetic background. The bee colonies in batch I (with a effective of 25 families) served as witnesses and were completed with queens naturally paired in the "nuptial flight" in the uninsulated space around the apiary. The bee colonies from group II - experimental (with a effective of 30 families) were completed with instrumentally inseminated queens.

Instrumental insemination of queens was performed in laboratory conditions according to the method of Руттнер Ф., 1975, using the special machine *Latshaw Insemination Instrument* (US production). The seminal material (sperm) freshly taken from the drones from the selected paternal families was inoculated into the respective genital organ of the queen in one go in an amount of 8 mm³.

The second experiment was conducted on two batches of bee families completed with queen-daughters of queen-mothers in the first experiment. The first batch consisted of 24 bee families completed with queen-daughters of queen-mothers naturally paired in the "nuptial flight" in the uninsulated space around the apiary. Experimental batch II consisted of 17 bee families completed with queens-daughters of queens-mothers inseminated instrumentally from experimental batch II of the first experiment. In this experiment, the queen-daughters of bee families from both batches were naturally mated in the "nuptial flight" in the uninsulated space around the apiary.

Throughout the beekeeping season, in the bee families from both batches involved in both the

first and the second experiment, the development levels of the main morpho-productive characters were researched and evaluated, such as: queen prolificacy, morphometric characters of bees - the length of the fallopian tube, the ulnar index and the discoidal dislocation, as well as the morpho-productive characteristics of bee families: colony strength, disease resistance, viability of the brood, honey production and winter hardiness.

The development levels of the nominated morpho-productive characters of queens, bee colonies, as well as the external ones of working bees, were evaluated, according to the methodology developed by us (Cebotari & Buzu, 2010) for the Zootechnical Norm regarding the value of bee families, breeding and certification of beekeeping breeding material, approved by Government Decision of the Republic of Moldova no. 306 of 28.04.2011.

The data obtained in the research were statistically processed using the computer software "STATISTICA-12", and the significance of the results was assessed, according to the certainty criteria of Student's error-free probability theory, by the methods of variational biometric statistics according to Плохинский (1989).

RESULTS AND DISCUSSIONS

The research results showed that the instrumental insemination of *Apis mellifera Carpatica* queens has a positive impact, first of all, on the development of the main morpho-productive biological characters of the first generation bee families, therefore, of the queen's own bee families. Subsequently, the positive effect is reflected on the level of development of the morpho-productive characters of the bee colonies from the second generation, therefore, of the bee families of the queen-daughters.

In the first experiment, performed on two batches of bee families with naturally paired queens and instrumentally inseminated, it was found that the prolificacy of the queens, as well as most of the morpho-productive characters of bee families with instrumentally inseminated queens had a significant growth evolution, compared to those of families with queens naturally paired in the nuptial flight of the uninsulated space around the apiary (Table 1).

Table 1. Level of development of morpho-productive traits of bee colonies supplemented with naturally mated and instrumentally inseminated queens

Character name	Batch 1, colonies with naturally mating queens (N = 25)	Batch 2, colonies with instrumentally inseminated queens (N = 30)	The difference, batch 2 - batch 1		t _d
			absolutely	%	
Prolificity, eggs / 24 hours	1648 ± 20	1812 ± 18	+164	10.0	6.10***
Horn length, mm	6.45 ± 0.02	6.64 ± 0.02	+0.19	2.9	6.71***
Cubital index,%	42.0 ± 0.5	46.3 ± 0.7	+4.3	10.2	5.0***
Discoid displacement +,%	71.5 ± 2.9	82.5 ± 2.1	+11.0	15.4	3.1**
Colony power, kg	2.62 ± 0.02	2.79 ± 0.02	+0.17	6.5	6.07***
Disease resistance,%	83.5 ± 0.9	86.9 ± 0.6	+3.4	4.1	3.15**
Brood viability,%	85.1 ± 0.9	89.1 ± 0.6	+4.0	4.7	3.70***
Honey production, kg	42.19 ± 1.11	50.58 ± 1.13	+8.39	19.9	5.31***
Winter hardiness,%	87.9 ± 1.1	90.3 ± 1.0	+2.4	2.7	1.61

Remark: + - positive discoidal dislocation; ** - P<0.01; *** - P<0.001.

It was found that instrumental insemination has a positive influence, first of all, on the queen's prolificity. Thus, the instrumentally inseminated queens from experimental batch 2 exceeded by prolificity, their contemporaries naturally mated from batch I (control), with 164 eggs/24 hours or by 10.0% (t_d = 6.10; P<0.001).

According to us, the increased prolificity of the queens in batch 2 is explained by the fact that instrumental insemination ensures a fuller filling of the queen's spermatoc with semen and sperm needed to fertilize the eggs. The saturated degree of filling of the spermatoc with the necessary sperm exerts a hormonal stimulation on the activity of the queen's ovarian glands, causing the activation of ovogenesis and increasing the prolificity of queens.

On the contrary, the natural mating of queens in the nuptial flight does not always ensure a sufficient saturation of the spermatoc with male semen. Therefore, some queens perform a few nuptial flights in the hope of filling the spermatoc with the necessary semen, and others, remain with the semiplepic spermatoc and usually have a lower prolificity.

Due to the fact that working bees from the families of instrumentally inseminated queens come from the paternal line from drones from selected families, with well-developed morpho-productive characters, they (bees) inherited from their parents a higher level of development of morpho-metric characters outside.

Thus, the worker bees from the families of experimental batch 2 of the instrumentally

inseminated queens significantly exceeded the length of the horn, their contemporaries from the families of batch I (control) of the naturally paired queens, by 0.19 mm or 2.9% (t_d = 6.71; P <0.001). This means that worker bees from batch 2 families have a higher capacity to capture nectar from the flower corolla tube of different honey plants, especially those with the deeper corolla flower tube.

The ulnar index of the anterior right wing of worker bees from the experimental batch 2 families of instrumentally inseminated queens was significantly higher compared to their contemporaries from the families of batch I (control) of naturally paired queens, with 4.3 absolute units, or 10, 2% (t_d = 5.0; P <0.001), which more adequately corresponds to the race standard.

The share of bees with positive discoid dislocation of the radial and ulnar ribs of the anterior right wing in the group 2 bee families with instrumentally inseminated queens was higher compared to their contemporaries in the group 1 families with queens naturally mated in nuptial flight, with 11.0 absolute units, or by 15.4% (t_d = 3.1; P<0.01), which also more adequately corresponds to the race standard according to this character.

Due to the greater prolificity of instrumentally inseminated queens, their bee colonies had a more abundant development of perennial brood, which contributed to the increase in the amount of bees in the nest. Thus, the power of bee families in batch 2 with instrumentally inseminated queens was significantly higher, compared to their contemporaries in batch 1

with queens naturally mated in the nuptial flight, by 0.17 kg or 6.5% ($t_d = 6,07$; $P < 0.001$). More eloquently, the advantages of bee families of instrumentally inseminated queens,

compared to those of queens naturally paired in nuptial flight, are reflected in the histogram (Figure 1).

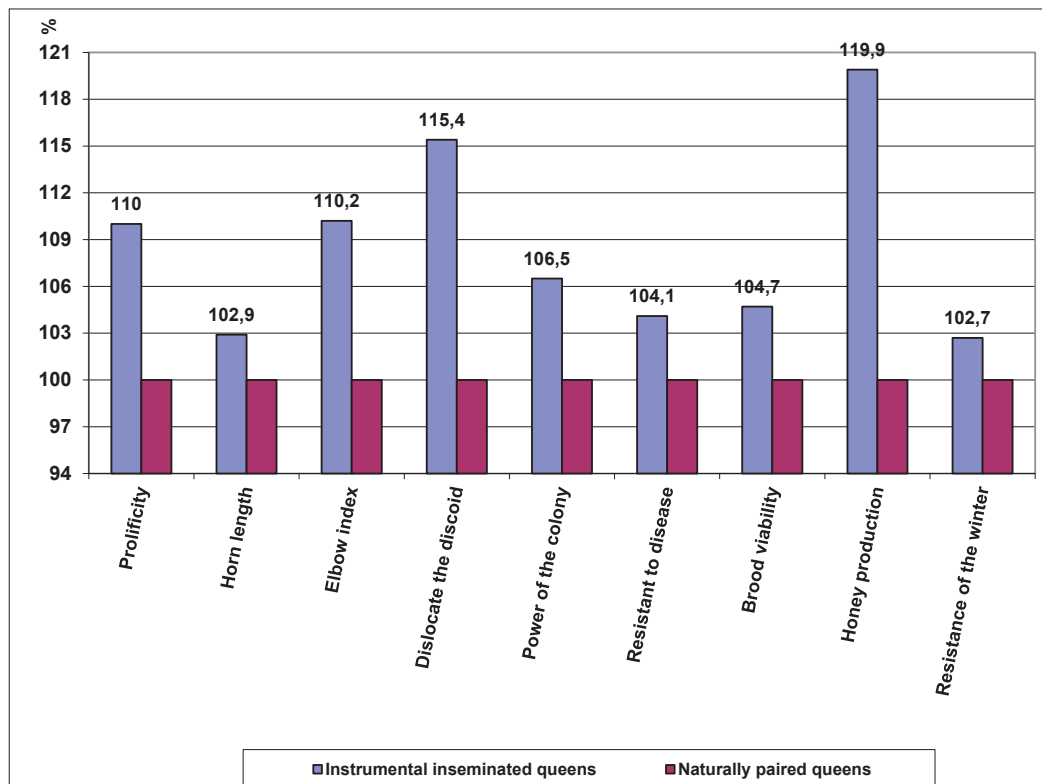


Figure 1. The value of the morpho-productive characters of the bee families with instrumentally inseminated and naturally paired queens

The histogram shows that the bee families in batch 2 with instrumentally inseminated queens essentially exceed, to a different extent, their contemporaries in batch 1 with queens naturally mated in the nuptial flight, according to the value of all the characters investigated. Due to the insemination of queens with drone semen from selected families, a generation of vigorous and disease-resistant working families was obtained, which in turn ensured an increased viability of the brood. Thus, bee families in batch 2 with instrumentally inseminated queens had a higher resistance to disease (hygienic instinct) compared to bee colonies in batch 1 with queens naturally mated in nuptial flight, with 3.4 absolute units, or with 4.1% ($t_d = 3.15$; $P < 0.01$). At the same time, the viability of the

brood of bee families from batch 2 with instrumentally inseminated queens was significantly higher, compared to that of the brood of bee families from batch 1 with queens naturally mated in the nuptial flight, with 4.0 absolute units, or with 4.7% ($t_d = 3.7$; $P < 0.001$).

Overall, given that the prolificacy of instrumentally inseminated queens was significantly higher, as well as the morpho-productive characters of the bee families of these queens had a more advanced development, they ultimately ensured a clear increase in capacity. accumulation in the nest of bee production.

Thus, the honey production accumulated in the nest increased from 42.19 ± 1.11 kg in the bee families from batch 1 with queens naturally

mated in the nuptial flight, to 50.58 ± 1.13 kg in the bee families from batch 2 with instrumentally inseminated queens. The increase was quite significant, constituting 8.39 kg, or 19.9% ($t_d = 5.31$; $P < 0.001$). This increase had the highest certainty threshold, according to the theory of probability of error-free predictions after Student (Плохинский, 1989).

It is important to mention that the bee families from batch 2 with instrumentally inseminated queens entered the winter strong and vigorous. In the spring of the following beekeeping year, it was found that bee families in batch 2 with instrumentally inseminated queens had a higher tendency to winter resistance compared to their contemporaries in batch 1 with queens naturally mated in the nuptial flight.

In the second experiment, conducted on two batches of bee families completed with queen-

daughters of queen-mothers in the first experiment, it was found that the natural mating of queens in nuptial flight causes a slight genetic segregation of the degree of development of morpho-productive characters of the second generation bee colonies. This is confirmed by the fact that the difference between the level of development of the morpho-productive characters of the bee families with queen-daughters from batch 1 and those with queen-daughters from batch 2 decreased.

At the same time, research has shown that the families of queen-daughters of instrumentally inseminated mother-queens differed in the positive direction from the contemporaries of daughter-daughters naturally paired in nuptial flight according to the biological features of the main morpho-productive characters (Table 2).

Table 2. The value of the morpho-productive characters of the bee families with queen-daughters obtained from naturally paired mother-queens and instrumentally inseminated

Character name	Batch 1, the queen-daughters of the mother-queens naturally paired (N = 24)	Batch 2, the queen-daughters of the instrumental-inseminated mother-queens (N = 17)	The difference, batch 2 - batch 1		t_d
			absolutely	%	
Prolificity, eggs / 24 hours	1782 ± 12	1815 ± 23	+33	1.9	1.27
Horn length, mm	6.57 ± 0.01	6.61 ± 0.01	+0.04	0.6	2.86**
Cubital index, %	45.7 ± 0.6	46.9 ± 1.1	+1.2	2.6	0.96
Discoid displacement +, %	77.0 ± 3.6	83.0 ± 2.1	+6.0	7.8	1.43
Colony power, kg	2.89 ± 0.02	3.01 ± 0.05	+0.12	4.2	2.26**
Disease resistance, %	88.5 ± 0.4	90.3 ± 0.6	+1.8	2.0	2.50*
Brood viability, %	90.1 ± 0.3	92.0 ± 0.6	+1.9	2.1	2.84**
Honey production, kg	41.92 ± 1.06	47.22 ± 1.41	+5.30	12.6	3.01**
Winter hardiness, %	80.7 ± 1.1	84.7 ± 1.4	+4.0	5.0	2.25*

Remark: * - positive discoidal dislocation; * - $P < 0.05$; ** - $P < 0.01$.

From these particularities, the difference is more pronounced according to the characteristics of the horn length, the viability of the brood, the resistance to diseases, the strength of the colony and, most importantly, the production of honey.

At the same time, analyzing the prolificacy of the queens in the comparative experimental batches, we found that the queens of the bee families in the experimental batch 2, which are the daughters of the instrumentally inseminated queens, had only a higher tendency of prolificacy compared to the contemporary queens in batch 1, because the difference between the value of this character of the

comparative queens was not significant ($P > 0.1$).

Such trends were also observed at the level of development of some external characters, such as the ulnar index and the positive discoidal dislocation of the nerves of the radial cell and the ulnar one of the anterior right wing.

Thus, the ulnar index in working bees of families in experimental batch 2 had a tendency to exceed, compared to contemporaries in batch 1, by 1.2 absolute units, or by 2.6%, the difference being insignificant ($P > 0.1$).

Such a trend was also found in the positive discoidal dislocation of the nerves of the radial and ulnar cells of the anterior right wing, which

is slightly higher in bees of families in batch 2, compared to contemporaries in batch 1, with 6.0 absolute units, or 7.8%, but this difference is not significant ($P>0.1$).

At the same time, the working bees of the families from batch 2, whose mothers were the daughters of instrumentally inseminated queens, substantially exceeded their contemporaries from batch 1, whose mothers were the daughters of queens naturally mated in the nuptial flight, by the length of the horn - by 0.04 mm, or 0.6% ($t_a = 2.86$; $P<0.01$). Given that the variability of this external character of bees is very narrow, this difference is quite significant with the certainty of the second threshold of the probability theory of error-free predictions after Student.

Significant differences in favor of bee families in batch 2 were found after other morpho-productive characters, quite important, such as

disease resistance (hygienic instinct) and viability of the brood, which shows directly or indirectly towards a higher resistance of these families against specific diseases.

Thus, the bee families of daughter queens obtained from instrumentally inseminated mother queens outnumbered their contemporaries, whose mothers were naturally mated in the nuptial flight, by disease resistance - by 1.8 absolute units, or by 2.0% ($P<0.05$) and according to the viability of the brood - by 1.9 absolute units, or by 2.1% ($P<0.01$).

More eloquently, the advantages of bee families with queen-daughters obtained from instrumentally inseminated mother-queens, compared to the families of queen-daughters obtained from naturally-paired queen-mothers, are reflected in the histogram (Figure 2).

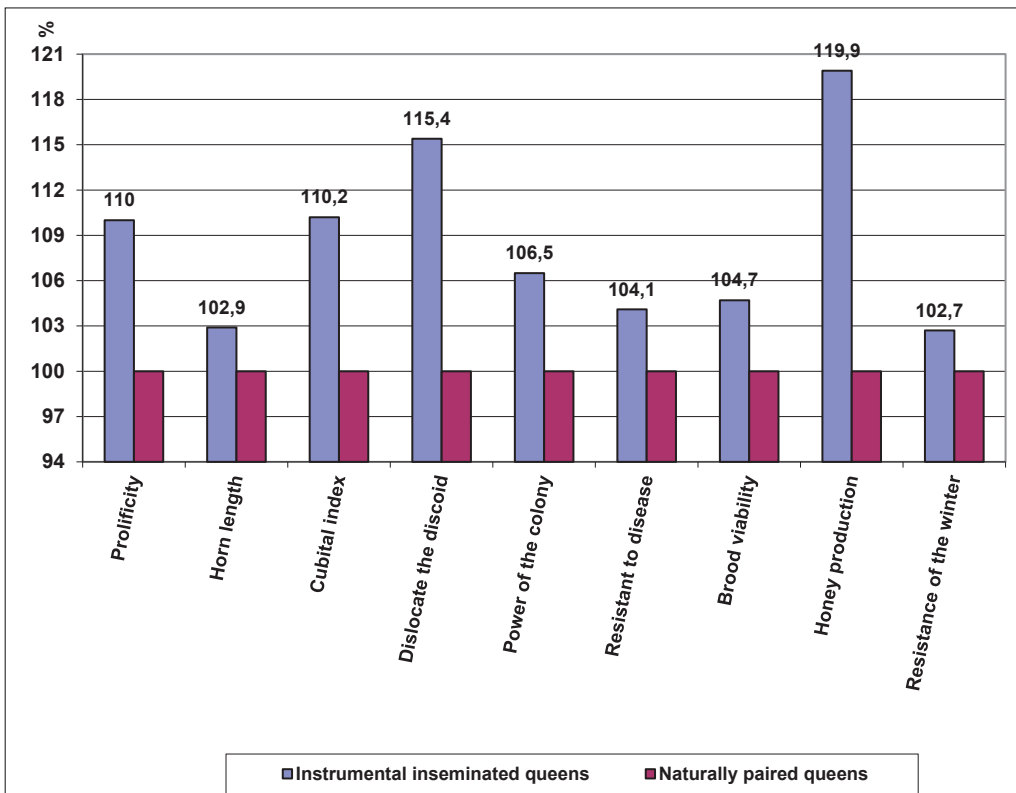


Figure 2. The value of the morpho-productive characters of the bee families with queen-daughters obtained from naturally paired queen-mothers and instrumentally inseminated ones

From the histogram it can be seen that the bee families with queen-daughters of the queen-

mothers inseminated instrumentally, exceed to a different extent, according to the level of

development of most of the morpho-productive characters researched, the bee families with queen-daughters of queen-mothers naturally paired in the nuptial flight.

Thus, the bee families in experimental batch 2, whose queens came from instrumentally inseminated mother queens, significantly outnumbered their contemporaries from mother pairs naturally mated in nuptial flight and after winter hardiness by 4.0 absolute units, or with 5.0% ($t_d = 2.25$; $P < 0.05$), as well as after the strength of the colonies - by 0.12 kg, or by 4.2% ($t_d = 2.26$; $P < 0.05$).

The most substantial advantage of bee families in batch 2, with queen-daughters of instrumentally inseminated mothers, is that they considerably outnumber their contemporaries in the control batch by the production of honey accumulated in the nest - by 5.3 kg, or by 12.6% ($t_d = 3.01$; $P < 0.01$). This difference is highly significant with the certainty of the second threshold of the probability theory of error-free predictions after Student (Плохинский, 1989).

The substantial overtaking of bee families with queens-daughters of queens-mothers inseminated instrumentally after honey production and winter hardiness, compared to those in the control batch, is due to the fact that the selection process in the bee population of the experimental apiary was directed to improve, first and foremost, these traits, as well as the strength of the colony, disease resistance and viability of the brood. As can be seen, these characters acquired in the selection process a more consolidated heredity, which is constantly passed down through inheritance from mothers to descendants.

The obtained data confirm the scientific conclusions of some researchers (Билаш & Кривцов, 1991; Бородачев et al., 1987), which states, that daughters of instrumentally inseminated mother queens, under all equal conditions, have a higher genetic potential for productivity than their contemporaries obtained from mother queens naturally paired in nuptial flight.

Therefore, generalizing the results of our research, we can conclude that the bee families of instrumentally inseminated mother queens, as well as of daughter queens obtained from instrumentally inseminated mother queens,

certainly possess a higher level of character development morpho-productive, compared to the contemporaries of queen-mothers and queen-daughters naturally paired in nuptial flight.

This was achieved due to the directed mating of the parental partners and the formation in the descendants of the working bees, as well as in the queen-daughters of a claimed inheritance with genetic potential of increased productivity. In all other equal conditions of maintenance and supply of nectar-polleniferous food, instrumentally inseminated mother-queens, as well as their daughter-queens, generate increased productivity and a higher economic effect.

In this sense, the advantages of instrumentally inseminated queens, as well as of daughter-queens obtained from them, are quite obvious and with high certainty. These advantages must not be ignored both by scientific researchers in the theoretical research-innovation activity and by beekeepers in the practical selection activity for the genetic improvement of bee colony populations, increasing productivity and production volumes, increasing the economic efficiency of the beekeeping branch.

CONCLUSIONS

1. Instrumental insemination of queens is an innovative technological method effective for increasing the productivity of bee families, increasing production volumes and raising the economic efficiency of the beekeeping branch.
2. Instrumentally inseminated queens have a higher prolificacy, compared to their contemporaries naturally paired in the nuptial flight, with 164 eggs / 24 hours, or 10.0% ($t_d = 6.1$; $P < 0.001$).
3. Working bees from the families of instrumentally inseminated queens had a higher development of external morpho-metric indices compared to their contemporaries from the families of queens naturally mated in nuptial flight, as humid to: horn length - by 0.19 mm, or by 2.9% ($t_d = 6.71$; $P < 0.001$), the ulnar index of the anterior right wing - by 4.3 absolute units, or by 10.2% ($t_d = 5.00$; $P < 0.001$) and the weight bees with positive discoid dislocation - by 11.0 absolute units, or by 15.4% ($t_d = 3.10$; $P < 0.01$).

4. The bee families of the instrumentally inseminated queens had a significantly higher development of the level of morpho-productive characters, compared to their contemporaries of the queens naturally mated in the nuptial flight, as hummed to: power of the colony - by 0.17 kg, or with 6.5% ($t_d = 6.07$; $P < 0.001$), disease resistance - by 3.4 absolute units, or by 4.1% ($t_d = 3.15$; $P < 0.01$), viability of the brood - by 4.0 absolute units, or by 4.7% ($t_d = 3.70$; $P < 0.001$) and honey production - by 8.39 kg, or by 19.9% ($t_d = 5.31$; $P < 0.001$).

5. Bee families of daughter- queens obtained from instrumentally inseminated mother queens have a higher genetic potential for productivity than their contemporaries of daughter- queens obtained from mother- queens naturally mated in nuptial flight, as follows: colony strength - 0.12 kg, or 4.2% ($t_d = 2.26$; $P < 0.05$), disease resistance - 1.8 absolute units, or 2.0% ($t_d = 2.50$; $P < 0.05$), viability of the brood - by 1.9 absolute units, or by 2.1% ($t_d = 2.84$; $P < 0.01$) and in honey production - by 5.30 kg, or 12.6% ($t_d = 3.01$; $P < 0.01$).

6. In the following winter, bee families of daughter- queens obtained from instrumentally inseminated mother- queens had a higher wintering capacity (winter hardiness) than their contemporaries of daughter- queens obtained from mother- queens naturally mated in nuptial flight, with 4.0 absolute units, or 5.0% ($t_d = 2.25$; $P < 0.05$).

7. The use for implantation (substitution of old queens) of instrumentally inseminated queens, as well as of daughter- queens obtained from them, ensures a selection effect in the genetic amelioration of the population of bee colonies in the apiary.

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