Research Article

Features of the Development of Beekeeping in the Narym Region of Russia

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Abstract | It has been determined that it is possible to successfully use bioresources in the Narym Region by growing herds of meat horse bred by means of the fattening technology. Besides, meat cattle breeding for fattening is also economically profitable, and what is most important, it is possible to establish profitable industrial beekeeping in this region. Profitable industrial beekeeping is based on assessing the food supply by special studies carried out on the area from west to east from the Kyshtovsky Area of the Novosibirsk Region to the left bank of the Ob River. On this territory 144 species of nectareous and bee-breading plants were found. They allowed two apiaries to experimentally get 5.5 tons of marketable honey of high ecological purity and high ecological quality. High-quality taste of the honey produced in the Vasyugan Region is confirmed by the tasters' commission. The quality of honey was assessed for the second time at the accredited test center of the Novosibirsk Interregional Veterinary Laboratory. The honey has been assessed on the annual basis for five years.

Keywords | Narym, Vasyugan, Ecological safe zone, Food, Meat cattle breeding, Industrial apiary, Fattening

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INTRODUCTION

The Narym Region is the northern territory of Western Siberia located to the north of 55º north latitude from the right bank of the Irtysh to the east and covering the Ob water basin to the border with the Turukhansk Region of the Krasnoyarsk Region in Eastern Siberia.

The main area of the Narym Region is covered with the world's largest Vasyugan Swamp. It stretches over the area from the west to the east for 573 km along the line of 55º of northern latitude and to the north for 320–350 km from this line (Kashkovsky and Plakhova, 2014).

The swamp is important in regulating the gas composition of the atmosphere. It has been maintaining the structure of the water balance and the hydrological regime of the swamp area for thousands of years. There are islands in the swamp. These are the area that is not covered with swamps and lakes, but covered with a forest, meadow glades with a magnificently growing natural food that is suitable for fattening of meat animals and beekeeping.

In the 21st century, the main role in producing and growing food is given to the ecological safety of the area. The authors have determined that in the context of Western Siberia and the whole of North Asia the Great Vasyugan Swamp serves as a huge natural filter an absorber of dust and various chemical pollutants of the atmosphere, including toxic ones. It is especially noticed that in the windless winter time, large Siberian cities–Novosibirsk, Kemerovo and others start to suffocate from smog, and only the movement of air masses from Vasyugan clears cities from the smog and other atmospheric pollutants. These observations are confirmed by other authors who study the ecology of Vasyugan (Chekryga, 2017).

Route surveys and valuation of the area have shown the availability of growing plants–cereals, legumes, motley grass – in the areas that are capable of feeding a thousand cattle, horses, and create thousands of stationary industrial apiaries. Given that a person does not plow, does not sow, and does not care for plants, they grow on their own and give a high yield every year. However, these territories that are rich in bioresources are not developed by a human due to the harsh climate and difficult terrain, i.e. the enormous wealth of the Vasyugan bioresources disappears without being used.

The use of Vasyugan bioresources has a problem: how can they be used without violating the environmental safety of the area? Having practical experience on developing difficult areas, after the route surveys of Vasyugan, it was determined that meat horse breeding and cattle breeding were the most profitable for feeding in this region. When fattening meat animals for feeding, it is possible not to construct livestock buildings. A summer camp will be required near good roads. Herds of horses and cattle herds can on their own master pastures 100 km from the camp. When the fattening is over, the herds will freely reach the camps in a few days, simultaneously increasing the live mass. In the camp they will be put into cattle trucks and taken to the meat factory. The quality of meat products made from environmentally safe areas will meet the highest requirements for taste and quality (Kashkovsky, 2000).

Out of all branches of the animal husbandry, beekeeping is the most difficult one in terms of care, maintenance, reproduction and other technological processes, but it is prominent because in difficult conditions it is a pioneer in the development of new territories or areas where the agriculture cannot be profitable.

In the late 1950s, in the Mountain Shoria, the agriculture in the Tashtagol and Kuzedeev areas of the Kemerovo Region brought losses. In the mountainous conditions, the collective farms could not get high yields. That is why even getting subsidies from the state, they began to go bankrupts one after another.

After several route expeditions, the authors determined that in these areas only the beekeeping industry could be profitable. Calculations were made to establish a beekeeping farm on the basis of collapsed collective farms. The Kemerovo Regional Committee of the Communist Party and the Regional Executive Committee approved and allowed to establish a bee farm.

In 1960, based on the authors' calculations, the Department of Beekeeping of the Kemerovo State Agricultural Experimental Station and the Regional Beekeeping Office organized the Tashtagol bee farm, the first large industrial beekeeping farm in Western and Eastern Siberia. For a short period of time this state farm became the most profitable one in the Kemerovo Region and Siberia. Thus, in 1968 this state farm had 8,000 bee families and 1,700 heads of meat cattle for fattening. The state farm sold 280 tons of honey to the state, and fully met the needs of the state farm with honey, milk and meat. There were 200 milk cows at the farm to meet its needs.

In addition, at low labor costs, the farm annually provided 1,700 heads (595 tons) of above the average fatness of meat cattle after fattening by feeding on natural mountain pastures (Kashkovsky, 1989, 1992, 2018).

Before developing bioresources of the Narym Region on its main territory the Vasyugan Swamp, the authors have analyzed foreign experience and the first Russian experience related to developing the beekeeping industry of the Polar lands. The foreign experience of the USA, Norway, Sweden and Finland shows that people live in all regions where there is the warm currents' flow the Gulf Stream, and they are engaged in agriculture and successfully keep bees (Vesterinen, 1971).

In Russia where the climate is more severe, the Gulf Stream washes the Murmansk Region. The further the areas are located from the Gulf Stream, the more and more severe the climatic conditions are and the more difficult it is for a human being to live.

The first experiments on keeping bees were made by G.B. Ankinovich and A.A. Lyubinov, beekeepers from the Moscow Timiryazev Agricultural Academy. The experiment turned out to be positive.

The first experiments on obtaining the Polar honey were enthusiastically met by the beekeeping community. On this occasion, M.M. Prishvin published an interesting story "Polar Honey".

In addition to the enthusiastic assessments of this first professional experience, Hawking and Sharplin (1965) wrote scientific works. They stated that in the northern regions, due to short summer and low air temperature, bees would not be able to live and produce marketable honey (Ankinovich et al., 1951; Chekryga, 2017).

Smirnov made attempts to establish an industrial apiary (2009–2010). He determined that the costs for establishing the apiary beyond the Arctic Circle were high and the obtained marketable honey would not cover them (Smirnov, 2009).

Taking into account all experiments made in various climatic conditions of the North, the authors have found out (Kashkovsky and Plakhova, 2010, 2014) that Vasyugan is an exceptionally ecologically safe territory where numerous orders and families of insects that breed nectar and pollen of plants successfully reproduce. It was necessary to define how *Apis mellifera mellifera L.* honey-bees adapted in these conditions. The authors solved this problem (Kashkovsky, 1970b). The purpose of the study was to assess the possibility to develop bioresources of the Narym Region.

Based on the solution of this question, it was necessary to solve such problems as:

1. How to colonize Vasyugan with honey-bees: to annually import or to reproduce and preserve them in these harsh climatic conditions.
2. Is the technology of keeping and caring for bees applied in the south of Western Siberia and in other regions suitable, or will it be necessary to develop a new one specifically for the north?
3. To assess the quality of bee products.

MATERIALS AND METHODS

The works were carried out in the area of the Vasyugan Swamp that occupies the entire northern part of the Novosibirsk Region. The works were performed from 1997 to 2016.

The authors determined and proved that the territory was unique in terms of the area and ecological safety as compared to any continent. Here the vegetation grows naturally. It can entirely provide meat horse breeding for fattening, cattle breeding and the beekeeping industry with food.

The technology of meat cattle fattening has been developed. It requires only practical implementation.

Beekeeping among small animal sciences is the most complex and sensitive to climatic conditions and the ecological situation. Therefore, it is necessary to solve the following issues: technologies for keeping and using bee families, the choice of bees' species that can actively live, reproduce, hibernate, and collect environmentally safe products in this climate. The main result of all agricultural experiments is economic efficiency (Kashkovsky, 1970, 1989, 2018).

These issues have been solved to the south of 55° north latitude in Western Siberia. As for the north of this parallel, they must be solved again here.

In the earlier works (Kashkovsky and Plakhova, 2014; Kashkovsky, 2019) it was defined that in the Vasyugan Region only two species could adapt: *Apis mellifera mellifera L.* and *Apis mellifera carnatica*. Other breeds cannot adapt in these conditions. They die in the first or second year (Kashkovsky, 1970b; 1989; Kashkovsky and Plakhova, 2010, 2014; Martynov, 1973).

The species that have adapted to the South Siberian conditions need the technology for keeping and breeding honey-bees. The development of the South-Siberian territories showed (Vorozhbitov, 1980; Kashkovsky, 1992) that not all technologies successfully implemented in the Russian Federation were suitable for Siberia. For example, the southern regions successfully use industrial queen breeding and early spring breeding of bee families to create package beekeeping. Long-term works on applying these technologies in the southern regions of Western Siberia, in the Kemerovo Region (1945–1954), the Novosibirsk Region (1958–2015) did not give a positive solution. In the more severe conditions of the north of Western Siberia, these technologies are unacceptable and require special research, developments and testing. Reproduction is the most important issue in the technology of keeping honeybees (Kashkovsky, 1989, 2000).

The optimal method of reproduction was searched for by a comparative experiment, successfully used in the Kemerovo technology of content and reproduction (Kashkovsky, 1970a, 1970b, 1989).

The experiment was carried out as follows: three groups of 25 similar bee families were formed from *Apis mellifera carnatica* bee families:

- Group 1 (control group) families were not reproduced, they were kept only for obtaining bee products: honey, wax;
- Group 2 was reproduced by 100 % individual nucleus for its laying queen;
- Group 3 was reproduced by 100 % combined nucleus.

All bee families were kept in single-wall stationary two-body hives per frame sized 435x300 mm. All of them were cared for by using the same technology.

Groups of bee families were selected by the analogue method. Similar families had the same number of frames in the nests, the age of the queens, the number of bees (3.5 kg) and the size of brood and food reserves.

The bee families taken for the reproduction and the resulting increase (new families) were researched in terms of their biological characteristics and economic qualities. The quality of queens was assessed by daily egg production and sowing quality during the whole season from placing from and putting into the winterer every 21 days according to the methods (Kashkovsky, 1970a, 1970b).

The result of wintering was assessed by the frames' wear, the number of dead bees, the hind intestine fullness, and the number of dead families in the groups. Swarming was assessed by the number of queen cells laid and swarm crop.

The mass of queens, worker bees, and drones was determined on the torsion scales in the number of 50–100 specimens from each family subject to the accuracy of 1 mg.

The productivity of each bee family in terms of the gross collection of honey and wax was assessed by using two methods. One method was as follows: each frame was removed from the hive or placed in the hive, then weighed with manual scales subject to the accuracy of up to 100 g. The final assessment was made on the scales: the honey collected for the season and left in the nests for feeding in autumn, winter, and spring was weighed.

The performance of each bee was defined by the load of the bag with nectar when the bee flew to the hive after working on flowers. To do this, 15 typical bee families were taken. When bees departed for the forage, 100 bees were caught from each bee family. Each bee was weighed subject to the accuracy of 1 mg, i.e. the live weight was determined. All species flying to collect nectar were labeled. Then, these 100 labeled bees were caught near the entrance in the beehive and weighed on the scales subject to the accuracy of 1 mg. After that, the bees' live weight they had before they had left was deducted from their mass. The difference was the load of the honey bag. The works were performed during the whole season: May, June, July, and August. The obtained data were analyzed according to the method of statistical analysis by Plokhinsky (1970) by using Microsoft Excel.

RESULTS AND DISCUSSION

In order to develop the harsh Narym Region, and its main territory–Vasyugan, it is necessary first of all to select a breed of bees that can actively exist during a zero-year period lasting 150–180 days. For this purpose, the authors used the results of experiments on the breed test made by the Department of Beekeeping of the Kemerovo State Agricultural Experimental Station (Kashkovsky, 1970b). According to the experiment, it was accepted that in the conditions of Vasyugan, two breeds of bees Central Russian and Carpathian bees could successfully survive and work. Moreover, in Western Siberia, the Carpathian breed spontaneously displaces hybrids and local bees from all apiaries (Avetisyan et al., 1970).

The presented results of defining the load of honey bag for 1,500 bees on average on a monthly basis show that in May it was 72.2 ± 0.50 mg, in June – 24.0 ± 0.69 mg, in July – 26.4 ± 0.78 mg, and in August – 19.7 ± 0.79 mg. The data presented by months show (Table 1) that the load of the honey bag of a working bee depends on the length of the day, air temperature and vegetation. In May, bees are born with a minimum live weight due to unstable air temperature and the release of nectar by spring honey plants. During one month, May bees died. The bees born in June had bigger body, longer proboscis and wings. The air temperature increased, and the number of plants producing nectar increased, which had a positive effect on the honey bag load. They increased by an average of 1.8 mg. In July, the air temperature was the highest, and there were most of the flowering species of nectariferous plants. This contributed to the birth of the largest bees whose weight of the honey bag increased by 4.2 mg more than that of the May bees.

In August, the working day of the honey-bee decreased by 2.5 hours. In August, nights became colder. For the entire month of observations, the maximum night temperatures reached only 10–11°C. In addition to these unfavorable factors, the strongest nectariferous species bloomed in July, and in August nectariferous flowers produced little nectar. This affected the load of the honey bag of the bees returning after collecting nectar. The load decreased as compared to May by 2.5 mg, and by 8.7 mg as compared to July. Thus, it is possible to state that in case of poor melliferous vegetation, the bees return to the nest with underloaded honey bags (Chekryga, 2017).

In addition to studying the impact of environmental factors on the honey bag load, the authors studied the effect of the bee family's power (number of working bees) on the quality of bees born in a strong and medium power family. For this purpose, *Apis carnatica* bee families were taken as a promising breed for the development of bioresources of the Narym Region.

The authors' observations of the bee families' power in the apiaries of Western Siberia showed that, on average, bee families in this region had 40 thousand working bees. According to F.A. Tyunin, such families are found on apiaries of highly qualified beekeepers. In the experiments at the apiary there were many bee families that had 60–96 thousand working bees (Kashkovsky, 2010).

In the area of the Narym Region where there was the apiary of D.T. Naychukov who kept *Apis mellifera mellifera L.* bees, the maximum power of the bee family reached 130 thousand bees.

To determine the effect of the bee family's power on the quality of working bees and their performance, two bee families were taken: a strong one 60 thousand working bees, and a usual one 40 thousand working bees. The results of the study are shown in Table 2.

Thus, it was determined that the bees born in a strong family were by 12 mg larger. Large bees bring by 8.2 mg of nectar and by 1 mg of pollen more for each flight. When working, bees make 6 flights a day, and each bee from a strong family will bring into the hive 49.2 mg of nectar and 6 mg of pollen more. Consequently, a strong family collects more honey, not only because of the greater number of field bees, but also because each bee from a strong family will bring by 49.2 mg more nectar per day than a bee from an ordinary family.

Previously, another advantage of strong families was defined. The bees from strong families turned out to collect nectar and pollen within the radius of 4,500 m, while bees from weak families flied within the radius of 2,695 m only (Gubin and Khalifman, 1953; Kashkovsky, 1989).

These studies allowed making a general conclusion that in order to develop bioresources of the Narym Region, it was necessary to use the technology of keeping bees that ensured breeding of strong bee families only.

In addition to taking into account the honey bag load (Table 1), the authors observed the work of the bee family that had 50 thousand working bees. For this purpose, every month during 30 days the authors defined how much nectar and pollens the bees brought each day. They were weighted by using electronic scales subject to the accuracy of 1 g. Table 3 shows the relevant data.

The work of the bee family in the Vasyugan on collecting nectar and pollen (Table 3) showed that the situation was the same by months as in case of the honey bag load. If the data are presented as a percentage, in May the family turned out to gather 19,380 g (100 %) of nectar and 459.6 g (100 %) of pollen for 30 days, in June – 21,600 g (108.12 %) of nectar and 669.2 g (145.5 %) of pollen, in July – 23,760 g (119 %) of nectar and 1,021.5 g (222.2 %) of pollen, and in August – 17,790 g (89 %) of nectar and 379.4 (82.5 %) of pollen.

During the whole season, the family gathered 83,240 g of nectar and 15,300 g of pollen. These figures convince that in the Narym Region, an ordinary bee family collects over 83 kg of honey per season. This is high performance even for southern Siberia.

To successfully develop bioresources of the Narym Region, it is necessary to have a technology for keeping bees that allows growing strong bee families. In the southern areas, the technology developed in the Kemerovo State Agricultural Experimental Station (1957–2017) is successfully used. One of the main elements of any technology for keeping bees is the issue of breeding bee families. Using the Kemerovo Bee Care System, southern areas successfully solve this problem. In the northern part of Western Siberia, the conditions of bees' keeping are much more complicated. That is why in these conditions it is necessary to study the problem of reproducing bee families.

Solving the problem on reproducing bee families was initiated on May 6, 2013. After the spring audit, three similar groups consisting of 25 bee families each were formed in the production apiary. Table 4 shows the characteristics of the bee families.

Analyzing the characteristics of the bee families from Table 4, it is possible to conclude that the selection of bee families by main similar features that have impact on the reproduction and honey collection and other qualities like the queens' age, the bee family power (number of bees), egg production (brood) and provision with food has been complied with requirements. The reproduction started on May 26, 2013.

All bee families were kept in Dadant-Blatt's double-body hives. They were cared for in a similar way. Only the type of reproduction differed.

In the first group, the bee families were not reproduced. They were cared for the bee families not to swarm, but only to collect honey and wax.

In the second group, one nucleus was created for its laying queen from each bee family. To do this, one frame with honey and cerago with the bees sitting on them was taken from the family. Then, 3 frames with the sealed brood and bees sitting on them were selected. In addition, the bees were shaken from two frames and the queen from their family was placed there. Two waxed frames and three frames with dry area were placed next to the brood. The entrance in these nucleus boxes were kept closed for the flight bees not to return to the old place on that day. The flight bees were detained for a day for the sealed brood not to thicken. On the next day, at 12 o'clock, the entrance was opened. The bees began to fly around during the flight, most of the flight bees returned to their families, but some bees remained in the nucleus box together with young house bees. On June 5, i.e. 12 days later, bees were born out of three frames. Together with those born from the sealed brood in the families on June 5, there were 39,000 bees. This enabled all families to expand their nests. For this, each nucleus box was given 3 frames with wax, and there were 12 frames in the nests. These families were not examined until June 14.

Table 1: Load of Honey Bag When Collecting Nectar in Vasyugan, mg.

Bee family	Average number of nectar collected by bees per day (mg)							
	Month of collecting							
	May		June		July		August	
	$_1$ ± S	Lim	$_2$ ± S	Lim	$_3$ ± S	Lim	$_4$ ± S	Lim
1	20.30±0.72	17-29	22.40±0.89	17-32	26.70±1.11	18-37	19.30±0.73	15-27
2	23.70±1.11	18-35	25.10±1.38	17-35	25.80±1.20	18-37	17.60±0.71	15-31
3	21.50±0.58	18-28	18.30±0.40	16-21	22.60±0.90	17-37	18.00±0.60	15-25
4	18.80±0.44	17-44	21.80±0.57	17-26	22.00±1.06	17-35	19.60±0.80	17-34
5	24.20±1.07	19-35	29.10±1.20	22-45	31.70±1.38	21-50	25.80±1.27	18-38
6	22.90±0.93	18-32	25.80±1.38	18-35	26.10±1.23	18-38	23.50±1.07	17-34
7	22.00±0.93	17-33	25.80±1.26	17-42	24.60±1.15	16-35	18.60±0.77	15-28
8	22.80±1.25	17-41	27.80±1.35	18-42	31.00±1.86	20-48	19.00±0.53	16-26
9	20.80±0.71	17-30	23.90±1.18	18-37	28.80±1.51	19-43	13.70±0.72	9-21
10	25.70±1.13	18-36	22.80±0.99	18-33	28.10±2.23	18-67	23.30±1.44	15-47
11	21.90±0.78	17-29	23.20±0.88	19-37	28.60±1.24	18-34	18.70±0.53	15-24
12	22.80±0.51	20-27	22.20±0.69	17-28	21.90±0.75	17-30	16.40±0.35	15-20
13	22.80±1.03	18-37	26.00±1.13	19-40	27.80±1.17	19-40	21.00±0.77	17-29
14	19.10±0.41	17-25	23.10±0.83	18-30	24.40±0.75	18-32	22.20±0.84	16-29
15	24.40±1.13	17-36	23.20±0.92	17-32	26.50±1.38	18-37	19.50±0.83	15-27
± S	22.2±0.50	17-44	24.0±0.69	17-45	26.4±0.78	16-50	19.7±0.79	9-47

Table 2: Effect of the Bee Family's Power on the Quality of Bees Born.

Indicators (mg)	Number of bees under study	Family – 60 thous. bees	Family – 40 thous. bees	Difference in the live weight
Weight of bees born	100	126±3.30	114.2±2.92	- 12 mg
Load of honey bag	100	30.5±1.65	22.3±0.69	- 8.2 mg
Load of pollen pellet	100	7.5±0.21	6.5±0.29	- 1 mg

Table 3: Nectar and Pollen (pollen pellet) as Collected by the Bee Family in Total per 30 Days a Month (g).

Type of work	May	June	July	August	Per season
Nectar collection	19,980 (100 %)	21,600 (108.12 %)	23,760 (119 %)	17,790 (89 %)	83,240
Collection of pollen pellet	459.6 (100 %)	669.2 (145.5 %)	1,021.5 (222.2 %)	379.4 (82.5 %)	15,300

Table 4: Characteristics of the Bee Families in the Groups Used for Reproduction in Vasyugan.

Groups	Number of families in the group	Age of queen bees	Number of bees in the family or power of the bee family, kg	Number of cells with brood, pcs.	Honey in the nest, kg
1 – control, families were not reproduced	25	12 months	2.5	35,760±25.0	8.0
2 – reproduction by individual nucleus for its queen	25	12 months	2.5	34,650±23.0	8.1
3 – reproduction by combined nucleus	25	12 months	2.5	35,700±26.0	8.0

On June 14, for the family to grow and to collect honey, one more body frame was installed for the nucleus. 6 dry space frames and 6 waxed frames were placed in the body frame. After such expansion of nests, bee families had not been examined until the forage was completed. If there was a deficit of dry space, all 12 frames with wax were placed in the second body frame. From June 14 until the beginning of the main forage on July 12, all nuclei managed to fill 12 frames each. Such placement of the body frame freed the beekeepers from unnecessary examinations and made it possible for the bees to work without the interference of the beekeeper. This is how a new family was obtained from each family that wintered, i.e. the apiary was increased by 100 %.

After selecting nuclei, the main families had five frames each with inoculation, open and sealed brood. Instead of the selected frames four frames with wax were given. Bees gave birth to emergency queens. In 25 days, the born emergency queens started laying eggs. On June 21, families with emergency queens were revised. The quality of the queens was determined by the quality of the laid eggs (sowing). At the same time, six frames with honey were taken from the families, each frame contained 4 kg of honey. Thus, due to savings in interrupting eggs' laying, in the second experimental group 24 kg of honey were received from each family. At the same time, instead of the selected frames with honey, six frames with wax were found in the nest. On July 8, one more body frame was placed for these families. Six dry space frames and six beeswax foundations were placed there. Until the end of the family's forage and the increase in this group, they were not examined.

In the third group on May 26, one combined nucleus was made. To do this, one frame of the sealed brood was taken from eight families. One frame with honey and cerago and three frames with wax foundations were added to the brood frame. In four hours a queen was taken from the breeding family and placed in the combined nucleus in this nucleus. After selecting the queen, the breeding family started cultivating emergency queens. On June 7, 31 sealed queens appeared in the family. One of them was left to the breeding family, 24 best queens were used to create combined nuclei. A sealed queen was added to each combined nucleus.

In 12 days the first combined nucleus with the laying queen from the breeding family is strengthened by the fact that bees are born from the sealed brood (eight frames). In 12 days the power in the nucleus reaches 5.9–6.0 kg. Therefore, one more body frame is placed on it. In the second body frame, along the edges a dry space frame is placed. Ten frames with a wax basis are placed inside. In 36 days, i.e. on June 14, the third body frame was put on this family (nucleus). At its edges one dry space frame with two wax foundations was placed, and its interior was filled with six dry space frames. Until the end of the forage this family was not examined. The results of the experiment are summarized in Table 5, which shows the results of the experiment.

The results of the experiment (Table 5) show that both methods of artificial reproduction allowed to increase the number of bee families by 100 % and made it possible for Group 2 together with the increase to get gross honey in the amount of 160.0±1.8 kg of honey and 2.58 kg of wax, and for Group 3 with the 100 % increase–104.0±2.0 kg of honey and 3.48 kg of wax. Thus, it was defined that the artificial reproduction of bee families in Vasyugan allowed obtaining 100 % of new families and, at the same time, collecting more honey and wax than from the families that had not been reproduced.

In Western Siberia, the most important factor was wintering of bee families. In Vasyugan, this factor is even more principle when developing bioresources by industrial beekeeping. Therefore, to finally solve the reproduction problem, it is necessary to carry out wintering of all families and their increase. The experiment was continued.

After the main forage, the nests were assembled for wintering. Before placing, the autumn revision was carried out. The power of the bee families, the provision with food, and the quality of food according to their suitability for feeding bees in the winter period were taken into account in all bee families. Table 6 shows the result of the autumn revision.

The records show (Table 6) that in winter all bee families had 2.5–2.7 kg of bees. Such families belong to the category of strong (Kashkovsky, 1970a, 1989). Two and a half kilograms of food (honey) per bee space were left with each family. The quality of honey was suitable to guarantee good wintering. The bee families wintered in an above-ground winter hive. The latter was filled with bee families on October 25, 2013. After placing the beehives with bees, the winter hive was closed and was not opened until placing the bees in spring. The temperature and humidity inside were determined through the ventilation pipes.

- The temperature in the winterer was from -2°C to +3.5°C.
- The relative humidity was 75 – 81 %.
- The bees were exposed from the winterer on April 16, 2014. Wintering lasted 174 days.

On April 16, the day of placing, the maximum air temperature was 10°C. At this temperature, the bees' flight was weak. The assessment of families in terms of the flight showed that the condition of families was good. There were no dead families, there were no drops of diarrhea on the frames and walls of the hives, i.e. the bees wintered without diarrhea. On April 20, the last spring revision was carried out. Table 7 shows the results.

All indicators on the quality of wintering were excellent: there were no dead bee families, no diarrhea, a small quantity of dead bees, the minimum palatability in all groups was 12.5 kg, and the maximum one was 13.5 kg. In the southern regions of Western Siberia through the example of 6,500 bee families, the average palatability was

Table 5: Efficiency of the Bee Families' Reproduction in the Vasyugan Region.

Groups	Number of experimental families	New families obtained (increase)	Obtained on average per 1 bee family			Left to be used by bee families in winter
			Gross honey per the main family (kg)	Gross honey in total, including the increase (kg)	Gross wax (kg)	
Group 1 – control	25	–	90.0±2.0	90.0±2.0	1.94	25
Group 2 – reproduced by individual nucleus	25	25	70.0±1.5	160.0±1.8	2.58	50
Group 3 – reproduced by combined nucleus	25	25	80.0±2.1	104.0±2.0	3.48	50

Table 6: Quality of the Bee Families to Be Kept in the Winter of 2013–2014.

Groups	Number of families to be kept in winter	Average power of families (kg)	Queen birth year	Note (in all families)
1 – control, families were not reproduced	25	2.70±0.3	2013	Queens were changed in 2013
2 – reproduction by individual nucleus for its queen	50	2.58±0.2	2013	
3 – reproduction by combined nucleus	50	2.55±0.4	2013	

Table 7: Result of the Bee Families' Wintering in the Vasyugan Region.

Groups	Families that were kept in winter	Died when kept in winter	Number of dead bees, bees per one family on average	Palatability of food on average per one family, kg
1 – control	25	–	1,500	12.5
2 – reproduced by individual nucleus	50	–	1,560	13.5
3 – reproduced by combined nucleus	50	–	14,50	13.1

Table 8: Efficiency of bee families in the Vasyugan Region.

Groups	Number of families	Gross honey collected kg	Feed consumption, kg	Marketable collection of honey, kg	Gross wax collected, kg
1 – control	25	49.7±4.1	28.0±1.1	21.7	1.17
2 – reproduced by individual nucleus	50	47.8±3.3	29.5±0.9	18.5	1.07
3 – reproduced by combined nucleus	50	53.6±2.1	29.0±0.8	24.6	1.20

Table 9: Quality of Types of the Honey Obtained in Vasyugan Apiaries.

Main indicators of quality	Sample No. 1 NSAU	Sample No. 2 apiary of S.P. Chub	Sample No. 3 apiary of V.F. Konarev	Admissible GOST
Weight share of moisture, %	16.80.7	16.2±0.6	17.2±0.7	21
Diastatic number, Goethe units	16.6±1.8	9.2±1.0	14.9±1.6	7.0
Acidity, cm	1.9	1.2	2.4	4.0
Weight share of reductive sugar, %	83.2±6.7	83.8±6.8	82.8±4.3	79.0-82.0
Weight share of sugar, %	0.02	0.02	0.02	6.0
Microelements				
Cadmium, mg/kg	Less than 0.01	Less than 0.01	Less than 0.01	Less than 0.05
Arsenic, mg/kg	Less than 0.02	Less than 0.02	Less than 0.02	Less than 0.5
Plumbum, mg/kg	0.023	0.028	0.024	1.0

12 kg (Kashkovsky, 1989). In Vasyugan, the palatability exceeded 1.5 kg–this was a very good result.

In the 2014 season, families were not reproduced, but they were studied for productivity.

Good wintering of the bee families had impact on their performance during the season. The honey collection was high (Table 8). The main conclusion is that the resulting increase in new families was complete. New bee families collected as much honey as bee families of the control group that were not reproduced.

The results of this experiment made it possible to conclude that it was possible to increase the number of bee families in the Vasyugan Region without expensive import of bees from other regions. In addition, the obtained increase convincingly proved their adaptation ability for the cold spring, autumn, and, most importantly, for the long wintering in Vasyugan.

The authors had previously defined that Vasyugan was an exclusively environmentally safe zone (Kashkovsky, 2010). In order to prove it, they made an assessment on the ecology again, and specifically tested the beekeeping products obtained in this region.

The main product is the honey collected by bees from the vegetation of this zone.

The honey quality was assessed for the first time by its taste. For this purpose, the honey taken from five apiaries that were located on the distance of 100–200 km from each other was studied. The organoleptic characteristics of the honey under study obtained the highest score. In terms of taste, it can compete and outperform all recognized varieties of honey: acacia, melilot, white, and cedar honey (Plakhova, 2015, 2018).

The most important assessment of honey was performed at the accredited test center of the Novosibirsk Interregional Veterinary Laboratory. For the study, samples of honey from the apiaries of the Novosibirsk State Agrarian University (NSAU), Sergey Petrovich Chub and Viktor Fedorovich Konarev were taken. Table 9 shows the results of the analysis.

The reproduction of bee families is one of the main issues in the technological process. This issue has been debatable since the end of the 18th century up to now. This issue is studied by beekeepers on all continents where *Apis mellifera L.* honey-bees are kept. The solution found by the authors in the region where natural conditions of the north of Western Siberia are extremely severe is a considerable human victory when developing the seemingly lifeless territory of Vasyugan.

The region of the northern part of Western Siberia discovered by the authors will become a very important national economic task when developing the Arctic basin.

In the conditions of Vasyugan, the Kemerovo Bee Care System that can be highly efficiently applied on stationary industrial apiaries of the entire Narym Region has proved to be efficient.

In the conditions of this region, where there are no highways and even gravel roads, apiaries cannot be moved from one place to another. Therefore, they will be established in a stationary way for 150–200 bee families. Using this system, 100 % of the bees were reproduced at the experimental apiary of the NSAU. One hundred and twenty bee families were reproduced to establish a subsidiary farm of the NSAU (the village of Kozlovo in the Kochenovsky area of the Novosibirsk region), and each year until 2009, 20–40 bee families were allocated to other farms. This convincingly confirmed the value of the Kemerovo Bee Care System in the conditions of Vasyugan.

DISCUSSION

Territorially, the Vasyugan Swamp is located almost on equal parts of the Novosibirsk and Tomsk Regions, occupying northwest a very small area of the Omsk Region. The Novosibirsk region accounts for an area of 1.6 million hectares. The studies had been carried out in this area from 1987 to 2018. These studies showed that the terrain was environmentally safe, and Organic Beekeeping could be established, and Organic Honey could be produced here. To establish Organic Beekeeping and produce Organic Honey, in this area there are 144 species of honey plants that annually provide bees with food, and stationary apiaries can produce from 5–7 tons of marketable honey. This ensures the 300 % profitability of apiaries. As a result of the comprehensive studies during 20 years, the authors have prepared the documentation that can be used to successfully solve the problem related to developing bioresources in the Narym Region.

CONCLUSION

1. The Vasyugan Swamp with its rich bioresources should be used as a source of ecologically safe food so as not to damage the ecology of this region. Meat horse breeding and cattle breeding for fatting are suitable for this purpose.
2. The whole territory of Vasyugan is suitable for establishing industrial stationary apiaries with high profitability, producing elite honey that is environmentally friendly and safe.
3. In order to develop bioresources of the Narym Region, the required production documentation is found at the Department of Biology, Bioresources and Aquaculture at the Biological and Technological Faculty of the Novosibirsk State Agrarian University. Based on this documentation, the Department can specifically develop a business plan.

AUTHORS CONTRIBUTION

All authors contributed equally.

CONFLICT OF INTEREST

There are no conflict of interests.

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