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Biological Resources of Entomophilous Plants and Melliferous Bees in Russia

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ABSTRACT

The paper examines the volume of biological resources of beekeeping, the possibility and feasibility of developing beekeeping in Russia on the basis of the available melliferous resources. An assessment of the economic effect of trophic connections between melliferous bees and entomophilous plants is provided. Beekeeping is an important branch of agriculture since pollination of entomophilous plants with the help of bees is a natural and most effective agricultural technique, which leads to a significant increase in the volume and quality of the yield of entomophilous plants. The development of beekeeping on a national scale is possible only with serious state support. For such participation of the state, it is necessary to have a clear understanding of the state of the industry, biological resources of beekeeping and the development prospects. In this regard, it becomes necessary to analyse the fodder base of beekeeping in the Russian Federation, to determine the potential reserves of honey and the prospects for the development of beekeeping in the Russian Federation. The volume and structure of honey resources are given, potential honey reserves, the number of bee colonies that can be kept on the basis of the available melliferous resources in Russia are provided. The melliferous resources of entomophilous plants in Russia make it possible to increase the number of bee colonies and the volume of commercial honey production by 8-9-fold, that is, to productively contain from 26 to 30 million bee colonies and produce from 386 to 452 thousand tones of commercial honey annually, which can satisfy scientifically supported honey consumption norms on a national scale. In conclusion, an assessment of the economic effect of trophic connections between honey bees and entomophilous plants is given. It is shown that with proper pollination of entomophilous cultivated and wild plants in Russia, the total economic benefit will equate to an impressive amount: about 1 trillion rubbles annually, which is equivalent to 15 billion US dollars.

Keywords: Bees, beekeeping, economic effect, pollination of agricultural crops, entomophilous plants, melliferous resources, biological resources, trophic connections.

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RELEVANCE OF THE TOPIC

The reason for the large-scale state development of beekeeping is a significant increase in the yield of agricultural crops and natural entomophilous plants during pollination using bees, the most complete use of biological resources of honey plants, the nutritional and medicinal value of bee products. The main income from beekeeping is not honey and other beekeeping products. The main thing is a significant increase in the yield and quality of seeds and fruits, caused by pollination with the help of bees. This is the basis for state support for beekeeping.

Pollination with the help of bees of entomophilous agricultural crops is a highly effective agrotechnical method leading to an increase in the quality of the yield of entomophilous plants: the increase in the yield of agricultural crops is up to 160%, and in greenhouses - up to 300% [1, 4]. In the work of A.Z. Brandorf [2] investigated the issues of the fodder base of beekeeping and the effectiveness of pollination activity of honeybees in agrobiocenoses, it was proved that intrahive training of honeybees increases seed yield by 1,8 times.

The role of bees as natural plant pollinators increases with the development of agriculture. The advantage of using honeybees (*Apis mellifera*), compared to other natural pollinators, is that bee colonies, each of which consists of several tens of thousands of individuals, can be placed next to the area in need of pollination. G.A. Avetisyan [1] pointed out that the indirect income from beekeeping, which can be obtained by using honeybees to increase yields and improve the quality of seeds and fruits of entomophilous plants, is almost 10 times higher than from direct beekeeping products.

N.I. Krivtsov, V.I. Lebedev, G.M. Tunikov in work [4] note that the cost of additional harvest of seeds and fruits, which are obtained as a result of pollination of entomophilous plants by bees, is 10–12 times higher than income from direct beekeeping products: honey, wax, propolis, bee bread, royal jelly, bee venom. Our method for assessing the importance of honey resources and the feasibility of developing beekeeping in Russia is as follows: first, we determine the country's need for beekeeping products, then we establish the possibility of obtaining these products, we estimate the cost of beekeeping products and apply the coefficients given in the works [1, 4]. According to the state accounting data in the Russian Federation, in the period from 1990 to 2019, 48-61 thousand tons of honey were produced per year. It follows from this that, in terms of one Russian citizen, the average consumption of honey was 360 g per year, or about 1 g per day.

In the work of G.A. Avetisyan [1] noted that the production of honey in the USSR was 280 g per year per capita - 16% of the honey consumption rate established by the Institute of Nutrition of the USSR Academy of Sciences.

According to the guidelines approved by the Ministry of Health of Russia on December 22, 1999 № 99/230 daily consumption of honey 10 grams.

According to the Apimondia World Association of Beekeepers in the European Union, the daily consumption of honey is 7-10 g per day per person.

Thus, to ensure a European and scientifically based level of honey consumption, that is, 7-10 grams per day, Russians will need 370-530 million kg of honey annually.
The purpose of this work is to show the possibility and feasibility of the development of beekeeping in Russia on the basis of the honey resources already available in the country by assessing the possible result of trophic relationships between honeybees and entomophilous plants with proper pollination of entomophilous plants.

MATERIAL AND RESEARCH METHODS

To assess the profit from the development of beekeeping in Russia, we proposed an algorithm that basically uses the potential honey reserves and a criterion introduced and recognized by the leading Soviet and Russian scientists in the field of beekeeping [1, 4].
Let us consider the melliferous base of the Russian Federation and prove that the plant melliferous resources currently available in Russia make it possible to obtain marketable honey in quantities that will provide scientifically grounded honey consumption rates for all citizens of the Russian Federation.
Forests are of prime importance in the composition of melliferous resources in the Russian Federation. Forest area – 840,2 mln. hectares, including those covered and uncovered by forest vegetation – 738,6 and 101,7 million hectares, respectively. The main wooded areas of the Russian Federation are coniferous: pine, spruce, cedar, tree juniper, larch and fir – 513,3 million. ha. The total area of agricultural land – 220,6 million hectares.
The total area of melliferous lands in the Russian Federation is 1146 million hectares, of which natural lands occupy 1077 million hectares, entomophilous agricultural crops – 27,6 million hectares.
Tables 1 and 2 show the results of calculations of potential honey reserves of the Russian Federation, performed in two versions [5]. Table 1 shows the potential honey reserves, taking into account all lands and plant communities that make a significant contribution (over 0,01%) to the country's potential honey reserves.

Table 1. General potential honey reserves and their structure

Melliferous lands	Area, thousand hectares	Stocks of honey	
		thousand tons	%
Total land	1145992,3	11539,4	100
Natural land, total	1077195,6	9693,5	84,0
including:	-	-	-
linden *(Tilia ps.)*	3323,8	1994,3	17,282
willow *(Salix ps.)*	5409,6	703,2	6,094
maple *(Acer ps.)*	339,7	67,9	0,589
white acacia *(Robinia pseudoacacia L.)*	53,4	24,0	0,208
kashtan *(Castanea vulgaris Lam.)*	47,2	2,4	0,020
other tree and shrub	32333,1	323,3	2,802
open spaces, clearings, burning	101658,6	2541,5	22,024
undergrowth and grasses of coniferous forests	553323,1	1660,0	14,385
undergrowth, grasses of deciduous forests	134151,1	402,5	3,488
swamps	152956,0	1529,6	13,255
pastures	68128,0	272,5	2,362
meadows	23993,0	168,0	1,455
ravines	1479,0	4,4	0,038
Cultural land, total	68796,7	1845,9	16,0
including:	-	-	-
sunflower *(Helianthus annuus L.)*	5325,6	266,3	2,308
alfalfa *(Medicago sativa L.)*	1952,2	195,2	1,692
clover *(Trifolium ps.)*	3700,3	185,0	1,603
sainfoin *(Onobrychis sativa L.)*	871,3	174,3	1,510
other perennial herbs	7554,1	528,8	4,582

buckwheat *(Fagópyrum ps.)*	1301,0	91,1	0,789
rapeseed *(Brassica napus L.)*	657,9	46,0	0,399
mustard *(Sinapis ps.)*	108,2	8,7	0,075
coriander *(Coriandrum sativum L.)*	16,5	1,7	0,014
honey plants of cereal crops	41161,3	123,5	1,070
fruit and berry crops	891,4	17,8	0,154
deposit	5148,0	205,9	1,784
melons	108,8	1,6	0,014

The first column of the tables indicates the type of melliferous land. The words "linden", "maple", "willow" mean that we are talking about a forested area where the dominant tree species is the tree stand of the corresponding species.

The second column shows the area of this type of melliferous land in terms of continuous stands. In the third column, the potential honey stock of each melliferous area is given. In the fourth column - the contribution of this type of melliferous land to the total potential honey reserves.

As can be seen from Table 1, the total potential reserves of honey in Russia are 11,5 billion kg, of which 1,8 billion kg are potential reserves of honey from agricultural lands, 9,7 billion kg are potential reserves of honey in natural melliferous lands. The contribution of natural melliferous lands to the total potential honey reserves is 84%, the contribution of cultural melliferous lands - 16%. Linden, willow, maple occupy the first places among tree species in terms of their contribution to the country's honey potential. Linden forests produce 1994 thousand tons of honey, which is 17%. But the total contribution of plantings of acacia, chestnut, Amur velvet and other woody melliferous plants is only 0,3% of the total potential honey reserves of the Russian Federation.

The well-known honey plant, white acacia, occupies only 53,4 thousand hectares and produces 24 thousand tons of potential honey reserves, which is 85 times less than the honey reserves of the linden stand, and is only 0,2% of the total potential honey reserves in Russia. There are melliferous lands whose contribution to the honey potential is very high. For example, the vegetation of the territory of burnt areas, clearings, open spaces, etc. produces 2,5 billion kg of honey (22% of the country's honey reserves), which is even more than the contribution of linden plantations. Such lands occupy a huge area – 101,7 million hectares, but their honey productivity is less than that of linden. In addition, most of these lands are located in hard-to-reach areas with climatic conditions not always suitable for beekeeping. Note that trees of such species as birch, beech, hornbeam, oak, aspen, alder, poplar, ash are not honey plants by themselves. But, in the forests formed by the stand of these species, there is a melliferous undergrowth and grasses. Sowing of entomophilous crops occupy 27,6 million hectares (4% of the area of melliferous crops in the Russian Federation), produce 1,722.4 thousand tons of potential honey reserves, which is 15% of the total potential honey reserves of the Russian Federation.

Huge melliferous resources are created by melliferous plants of burns and other uncovered forest vegetation areas – 2,5 million tons, as well as weed-field melliferous plants in the fields of cereal crops - 1846 thousand tons of honey, which is 16% of the total potential honey reserves. Despite the prevalence of honey from natural lands over cultural ones, the latter are of greater interest for honey beekeeping today, since they are provided with transport routes, have, on average, higher honey productivity, are cultivated in a planned manner, are more concentrated and occupy significant areas.

Table 2 presents the “concentrated potential honey reserves”, as their constituent melliferous lands have higher honey productivity. This option did not take into account the territories, the honey productivity of which is relatively low: the area under cereal crops, coniferous forests, deciduous forests of non-bearing tree species, swamps, pastures. In addition, the calculation did not include some hard-to-reach territories and territories with climatic conditions unsuitable for beekeeping.

Table 2. Structure of concentrated honey reserves in the Russian Federation

Melliferous lands	Area, thousand hectares	Stocks of honey:	
		thousand tons	%
Total land	122089,8	5933,6	100,0
Natural land, total	94454,5	4211,2	71,0
including:	-	-	-
linden *(Tilia ps.)*	3323,8	1994,3	33,6
willow *(Salix ps.)*	5409,6	703,2	11,9
maple *(Acer ps.)*	339,7	67,9	1,1
kashtan *(Castanea vulgaris Lam.)*	47,2	2,4	0,04

white acacia *(Robinia pseudoacacia L.)*	53,4	24,0	0,4
other tree and shrub	18720,8	187,2	3,2
open spaces, clearings, burning	42566,9	1064,2	17,9
meadows	23993,0	168,0	2,8
Cultural land, total	27635,4	1722,4	29,0
including:	-	-	-
sunflower *(Helianthus annuus L.)*	5325,6	266,3	4,5
alfalfa *(Medicago sativa L.)*	1952,2	195,2	3,3
clover *(Trifolium ps.)*	3700,3	185,0	3,1
sainfoin *(Onobrychis sativa L.)*	871,3	174,3	2,9
other perennial herbs	7554,1	528,8	8,9
buckwheat *(Fagópyrum ps.)*	1301,0	91,1	1,5
rapeseed *(Brassica napus L.)*	657,9	46,0	0,8
mustard *(Sinapis ps.)*	108,2	8,7	0,1
coriander *(Coriandrum sativum L.)*	16,5	1,7	0,03
fruit and berry crops	891,4	17,8	0,3
deposit	5148,0	205,9	3,5
melons	108,8	1,6	0,0

The volume of concentrated potential honey reserves is about 5,9 billion kg. Natural lands occupy 94,5 million hectares. and producing 4,2 billion kg (71%) of concentrated potential honey reserves. Entomophilous agricultural crops occupy 27,6 million hectares and produce 1,7 billion kg (29%) of concentrated potential honey reserves.

The linden tree stand, although it occupies only 2,7% of the melliferous area, produces 33,6% of the concentrated potential honey reserves.

Table 3 shows a list of plants whose contribution to honey potential is relatively small, and which for this reason were not included in separate rows in Tables 1 and 2. The right-hand column of the table shows the percentage of the contribution of each plant type relative to the maximum honey reserves of the Russian Federation, i. e. about 11539 thousand. The total contribution of these, these "non-included" melliferous plants is less than the contribution of the melliferous plant coriander, which closes the table 1.

Table 3. Plants not identified in the structure of honey reserves in the Russian Federation

Honey plants		Occupied area [thous. ha]	Honey production [kg / ha]	Honey stocks [t.t]	[%]
English name	Latin name				
Apricot	Armeniaca vulgaris Lam.	1,8	25	0,045	0,0004
Amur velvet	Phellodentron amurense Rupr.	1,8	250	0,450	0,0039
Hawthorn	Crataegus ps.	1,8	25	0,045	0,0004
Gledicia	Gleditschia triacanthos L.	5,4	200	1,080	0,0094
Grebenshik	Tamárix ps.	7,6	50	0,380	0,0033
Pear	Pyrus ps.	16,5	20	0,330	0,0029
Derain	Cornus ps.	0,1	15	0,002	0,0000
Juzgun	Calligonum ps.	5,1	30	0,153	0,0013

Zelkva	Zelkova ps.	0,4	50	0,020	0,0002
Loch	Elaeágnus ps.	7,1	10	0,071	0,0006
Walnut	Juglans regia	10,1	50	0,505	0,0044
Nut	Juglans mandshurica	5,4	50	0,270	0,0023
Manchurian	Rhododendron ps.	8,9	100	0,890	0,0077
Rhododendron	Halóxylon ps.	0,7	25	0,018	0,0002
Saxaul	Buxus ps.	3,0	20	0,060	0,0005
Boxwood	Prúnus ps.	0,6	25	0,015	0,0001
Plum	Ribes ps.	3,5	70	0,245	0,0021
Currant	Prúnus ps.	5,9	5	0,148	0,0013
Bird cherry	Morus ps.	0,4	25	0,010	0,0001
Mulberry	Malus domestica Borkh.	3,1	20	0,062	0,0005

The results of the work [5,6,11] showed that the honey resources of Russia will make it possible to obtain annually from 386 to 452 thousand tons of marketable honey. For this, it is enough (even without increasing the honey productivity of a bee colony, which in the Russian Federation is about 15 kg of marketable honey per year) to increase the number of bee colonies in the country by 8-9 times. In most regions, honey resources can increase the number of bee colonies by 3-10 times, and in some areas - more than 20 times [3].

The number of bee colonies that can be kept on the honey base available in Russia is 26-30 million [6]. The market value of such a quantity of honey is approximately 200-250 billion rubles, and the profit from the sale will be 70-80 billion rubles in year. Taking into account the cost of additional beekeeping products (wax, propolis, milk, bee bread), the profit from the sale of beekeeping products will amount to about 100 billion rubles in year [6,10,13].

Guided by the criterion described in the works [1, 4] according to which the indirect income from beekeeping, the value of the additional harvest, the quality of seeds and fruits that are obtained as a result of pollination by bees, is 10-12 times higher than the income from direct beekeeping products, based on the above higher than the volume of beekeeping products and an estimate of their value in the amount of 80-100 billion rubles), we obtain that income from proper pollination of entomophilous agricultural crops and natural entomophilous plants of the Russian Federation can reach one trillion RUB annually, which is equivalent to 15 billion USD.

CONCLUSION

Thus, this is a huge economic benefit for the country. This benefit is directly related to the further development of beekeeping in our country, and on the basis of the honey resources already available in Russia.

It should be emphasized that due to the unique trophic relationships of honeybees and entomophilous plants, nectar is a renewable biological resource, and pollination with the help of honeybees is a natural and most acceptable ecological method of pollination of entomophilous plants [7,8,9,12,14]. Considering the above, we state that for the further development of agriculture, the rational use and reproduction of biological resources, which include honey plants, bees and their products, are of particular importance.

We express the hope that the values of the expected profit from the development of beekeeping in Russia, given in the article, will be taken into account when solving issues of support and development of the beekeeping industry, both from the state and from private investors.

REFERENCES

1. Avetisyan G.A. Pchelovodstvo / G.A. Avetisyan. - M.: Kolos, 1982. – 309 s.
2. Brandorf A.Z. Biotekhnologicheskiye aspekty ispol'zovaniya pchelinykh semey (Apis mellifera L.) v usloviyakh Severo-Vostoka yevropeyskoy chasti Rossii: diss. … d-ra. s.-kh. nauk / A.Z. Brandorf. - Kirov, 2013. – 277 s.
3. Burmistrov A.N., Kulakov V.N. Kontseptsiya «Ratsional'noye razmeshcheniye pchelovodstva s uchetom medonosnykh resursov i potrebnosti v pchelakh dlya opyleniya sel'skokhozyaystvennykh kul'tur po regionam Rossii» / A.N. Burmistrov, V.N. Kulakov // GNU NII Pchelovodstva Rossel'khozakademiya. — Rybnoye, 2003. – 27 s.
4. Krivtsov N.I. Pchelovodstvo / N.I. Krivtsov, V.I. Lebedev, G.M. Tunikov. - M.: Kolos, 2007. - 512 s.
5. Kulakov V.N. Medonosnyye resursy i perspektivy razvitiya pchelovodstva Rossiyskoy Federatsii: dis. … d-ra biol. nauk / V.N. Kulakov. – M., 2012. – 362 s.
6. Kulakov V.N. Otsenka medovykh zapasov sub"yektov Rossiyskoy Federatsii. Vestnik Rossiyskoy akademii sel'skokhozyaystvennykh nauk.2011. №6. S.81-83
7. Moreva L.YA. Ekologicheskiye osobennosti pchely medonosnoy (Apis mellifera L.) na yuge Rossii: dis. … d-ra biol. nauk / L.YA. Moreva. - Krasnodar, Stavropol'skiy gosudarstvennyy universitet. 2007. - 308 s.
8. Narchuk E.P. Nektar kak vozobnovlyayemyy biologicheskiy resurs / E.P. Narchuk, L.YA. Moreva // Biosfera. - 2016. - T. 8. - № 3. - P. 301-314.
9. Pribylova Ye.P. Troficheskiye vzaimodeystviya nasekomykh opyliteley i entomofil'nykh rasteniy v ekosistemakh: monografiya. / Ye.P. Pribylova, Ye. S. Ivanov. - Ryazan': Ryazanskiy gos. un-t imeni S.A. Yesenina, 2010. – 148 s.

10. Kulakov V.N. Melliferous resources of the Russian Federation. -M.,2015, - 252 page.
11. Kulakov V.N. Medonosnyye ugod'ya i medovyy potentsial RF / V.N. Kulakov // Vestnik Rossiyskoy akademii sel'skokhozyaystvennykh nauk. - 2010. - № 4. - P. 78-80.
12. Brandorf A.Z. Vlyainiye dressirovki na poseshchayemost' klevera lugovogo. //Pchelovodstvo. -2011. № 7. -P.23-25.
13. Kulakov V.N. Struktura medonosnoy bazy RF // Pchelovodstvo. -2012, - № 3.- P.22-23.
14. Brandorf A.Z., Ivoilova M.M. THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE QUALITY STANDARDS OF ROYAL JELLY APIS MELLIFERA L.
15. Federal Agricultural Research Center of the North-East named N.Rudnitsky. Agrarnaya nauka Evro-Severo-Vostoka. -2018. №1(62). P. 19-26.