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Nectariferous potential and cadastral evaluation of honey resources of the wildlife Altyin Solok Reserve created for the conservation and reproduction of the Burzian population of the *Apis Mellifera Mellifera* L.

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Abstract

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The study of the honey potential of a certain region is necessary for the organization of intensive technologies for keeping bees colonies allowing rational use of honey resources of the area. The work on the cadastral evaluation of honey resources allows carrying out an economic appraisal of the production potential, planning the prospects and forms of beekeeping development in the given area. The purpose of this work is to study the floristic composition of the main honey plants of the Altyin Solok Reserve, to determine the honey reserve and to conduct a cadastral evaluation of honey resources of the wildlife reserve. It was found that the dominant honey plant in the reserve is small-leaved Linden (*Tilia cordata Mill.*), which forms more than 90% of the honey reserve of the studied area. In this studied area nectar bearing capacity of lime-tree, thickets of Norway maple and mixed herbs are designated quarterly in forest clearings. The main honey plants are 18 trees, 23 shrubs and 221 herbaceous species. On the territory of the wildlife Altyin Solok Reserve the main and supporting honey collection is formed by 94 species of honey plants. The calculation of the appropriate production and the cost of bee products in the wildlife Altyin Solok Reserve were made. A map of the quarterly zoning of this reserve for the organization of bee pasture areas with the designation of the wild hive or apiary type of bee families' content in the reserve was produced. The methodology of integrated assessment of bee forage is developed that includes a floristic description of nectar plants, the definition of nectar bearing capacity of territories of productive bees flight and a form of a rational organization of the bee families content as well as the cadastral evaluation of the melliferous resources and appropriate volume of bee produce. The technique can be used in any region to assess the area where beekeeping is introduced for the first time as well as to optimize the content of bee colonies in the developed areas.

Keywords: ecology; honey bee; wildlife reserve; Altyin Solok; forest; dark bee; *Apis mellifera*

Introduction

The dark forest bee of the *Apis mellifera mellifera* subspecies had a natural habitat along the Northern border of Eurasia and it was optimally adapted to the continental cold climate (Jensen et al., 2005; Whitfield et al., 2006; Shaibi & Moritz, 2010; Ilyasov et al., 2011). Over the past two centuries the area of the dark forest bee in Eurasia has significantly decreased due to intensive deforestation, mass introduction into the Northern territories of the southern subspecies of bees, the spread of new pathogens that cause ascospherosis, aspergillosis, nosematosis and other diseases of bee colonies (Kleea et al., 2007; Mishukovskaya et al., 2018). As a result of the development of industrial beekeeping there were massive movements of bee families beyond their natural habitats which created a threat of loss of purebred of aboriginal genetic pools of subspecies because of cross-hybridization (Cao et al., 2017). The control of the nomadic way of beekeeping using methods of identification of taxonomic affiliation will help to preserve the genetic pool of the subspecies *A.m. mellifera* (Ilyasov et al., 2016). Up to this moment dozens of methods have been developed to identify the taxonomic affiliation of bee families which are based on the variability of body parts, allozyme loci, mitochondrial DNA, microsatellite loci of nuclear DNA, single nucleotide replacement sites (SNP) (Ilyasov et al., 2016).

In Russia, the local forest dark bee *A. m. mellifera* was hybridized on the most of the territory with imported subspecies *A. m. caucasica* and *A. m. carpatica* (Ilyasov et al, 2007). The genetic pool of native forest dark bee *A. m. mellifera* is currently lost in many countries of Europe (Jensen & Pedersen, 2005). The large amounts of clean lines of dark forest bees *A. m. mellifera* in Eurasia presumably remained in Russia: in the Republic of Bashkortostan in the southern Urals, in the Perm region, middle Urals (Ilyasov et al, 2007). The preservation of the purity of the genetic pool of the Burzian wild-hive dark forest bee and confirmation of its belonging to the subspecies *A. m. mellifera* is a crucial task for beekeepers, researchers (Ilyasov et al., 2016).

In Burziansky district of the Republic of Bashkortostan the most numerous populations of the Burziansky wild-hive ecotype of this subspecies remained that is adapted to abundant flowering of tillet *Tilia cordata* (Yumaguzhin, 2010; Ilyasov et al., 2017). The evolution of the Burzian ecotype of the dark forest bee is related to the silver lime *Tilia cordata* as it is the main source of nectar and pollen (Yumaguzhin, 2010). According to the results of pollen analysis of honey collected from the Burzyansky wild-hive, Caucasian yellow and crossbred bees it was established that the Burzian wild-hive bees are superior in honey productivity to other species of bees. They are focused on the honey yield from lime (Yumaguzhin, 2010) and a feature of floristic specialization of the Caucasian bees for example is honey collection from herbaceous plants (Ilyasov et al., 2015).

Lime forests are widespread throughout the world and are locally important members of Northern temperate broadleaved forests providing bees with nectar and pollen (Pigott, 2007; Dabrowska et al., 2016; Konashova et al., 2018). The process of nectar extraction is a complex physiological process that depends on natural and climatic factors, the morphological and physiological characteristics of the plant itself (Roshchina & Roshchina, 1993; Bogdanov et al., 2007). Features of the structure of the Linden flower, unstable abundance of its flowering over the years, the influence of weather factors on the nectar release, changes in the composition of nectar during its fermentation from flower to honey as well as the dependence of nectar productivity on the age and density of Linden plantations are factors of instability in the development planning of the beekeeping. And they force to adjust the volume of production of bee products (Naef et al., 2004; 2007; Farkhutdinov et al., 2013; Jacquemart et al., 2018). In this regard it is important to conduct a cadastral evaluation of honey resources which allows to plan the average production of bee products in a certain area on the one hand and to calculate the number of bee colonies that can be rationally contained in the estimated area on the other hand (Farkhutdinov et al., 2013; Khisamov et al., 2014; Varlamov et al., 2016).

Lime tree forests in the Republic of Bashkortostan occupy 1072.9 thousand ha of Forest Fund and make 36% of the area of all lime forests in Russia (Yumaguzhin, 2010). In 2012 with a decision of UNESCO was created biosphere reserve “Bashkir Urals” which is included in the world network of biosphere reserves. “Bashkir Ural” is located on the Western slopes of the southern Urals and covers a total area of more than 345700 ha (Ilyasov et al., 2015). Its membership includes five specially protected natural territories of Federal and Republican values: the reserve “Shulgan-Tash”, the National Park “Bashkiria”, the Natural Park “Muradymovskoye gorge”, the wildlife Altyin Solok Reserve and “Ikskiy”.

The Altyin Solok Reserve was established in 1997 to optimize the number, to range expansion and to maintain the genetic purity of native populations of the Burziansky wild-hive forest dark bees *Apis mellifera mellifera L.* inhabiting natural and artificial hollows, to preserve traditional handicrafts as wild hive beekeeping including as a security (buffer) zone around the reserve “Shulgan – Tash”.

Due to the fact that economic activity on the territory of the reserve is limited (prohibited timber cutting) the use of non-timber forest products provides an important contribution to supplementing the budget of the families of the rural population living near the reserve (Shackleton & Shackleton, 2004). For the rational use of non-wood forest products the production of bee products plays an important role and, accordingly, the development of this direction is impossible without knowledge of honey resources and their productive potential (Khisamov et al., 2014; Güngör, 2018; Özkırım, 2018).

The relevance of the conducted research is connected with the need to assess nectar bearing capacity in different blocks of the Altyin Solok Reserve and the organization of rational beekeeping on its territory which is associated with the preservation and increase in the number of bee families of unique Burziansky populations of forest dark bees *Apis mellifera mellifera L.* and full use of the melliferous resources of the refuge. In this regard the purpose of our research was geo-botanical, resource and cadastral evaluation of honey resources of the reserve as a basis for the development of scientific and industrial bases of beekeeping in the given region.

Material and Methods

Study area

Field works were carried out from 2016 till 2018 in the wildlife Altyin Solok Reserve located in the Burziansky district of the Republic of Bashkortostan. The reserve is located on the mountainous territory of the upper reaches of the Nugush River and the Belsko-Nugush interfluves area with the most elevated central part of Masim town (53°09′07″ north latitude, 57°15′18″ east longitude). The Eastern border of the reserve is 8 km west to the village of Starosubhangulovo. In total within the boundaries of the reserve there are 90273 ha of land including: forest lands (87776) ha, agricultural lands and other categories are 2497 ha. The reserve is located on 74 blocks of Nugush forestry of Burzianskiy district forestry, on 54 blocks of Gadelgareevo forestry of Burzianskiy district forestry and on 4 blocks of Belskiy forestry of Burzianskiy district forestry.

Before the beginning of work we made routes of inspection on blocks and then inspection of grounds started. The route of the expedition was laid on the basis of the forestry regulations of the State Department "Burzyan forestry", the availability of roads (based on the future possibility of organizing apiaries on the route), consultations with employees of the Altyin Solok Reserve (for a sample of typical forest and grasslands).

Geo-botanical, resource and cadastral evaluation of melliferous resources

During the expedition research in the territory of the Altyin Solok Reserve we examined the floristic composition of honey plants, nectariferous resources of the most productive biocenoses (Khisamov et al., 2018). The number of honey plants and the area of forest and meadow occupied by them were determined by special examination (Farkhutdinov et al., 2013).

The number of woody honey plants and the area occupied by them in the forest structure is estimated when moving along a pre-planned route counting of all nectariferous trees (by species) growing in a four-meter strip (2 m to the right and 2 m to the left) along the way. On the way back nectariferous shrubs were also taken into account. Having finished the calculation we computed the number (in %) of nectariferous trees and shrubs, determined the area occupied by them. Then in laboratory conditions based on the class of bonitet, relative completeness and age of trees nectar bearing capacity of relatively pure lime-tree forests was calculated (Farkhutdinov et al., 2013; Khisamov et al., 2018). Accounting nectar bearing capacity of other types of nectar trees (willow, maple) was conducted in a similar manner. In addition the calculation and the location of the arrays of trees (poplar, birch, aspen) as the source of propolis were carried out.

To calculate honey productivity of lime in the composition of the different plantations we used the formula:

$$M = N \times 0.1\, K \times C \times S,$$

where: M – honey productivity of small-leaved linden at the site of the study; N – honey productivity per 1 ha (reference data); K – coefficient of small-leaved Linden in the composition of the plantings (determined on the test site); C – the duration of flowering of small-leaved Linden, days (usually 14 days); S – the area of the studied site.

When determining the total available amount of nectar for bee colonies we take into account that bees collect no more than 30% of nectar in the 2-3 km zone around the apiary (Heil, 2011; Farkhutdinov et al., 2013; Khisamov et al., 2018).

The choice of the place of description of herbaceous nectar plants was carried out by the method of typical selection (Waldéna et al., 2017). Sites were laid on homogeneous sites (Milberg et al., 2016). There were at least 10 geo-botanical descriptions in each test site (TS). Nectar productivity was determined by counting the stalks of nectariferous plants per 1 m^2. The area was examined on the diagonal, every 100 – 200 m we laid area of 1 m^2 and counted the number of each nectar plants in the grass. To do this the entire amount of plants was taken as 100% and the percentage of each species

was calculated. According to the ratio of plants in the herbage the area was determined which in total accounted for the share of the corresponding honey plant in the entire area of the meadow (Heil, 2011; Farkhutdinov et al., 2013).

On the basis of reference data, the total stock of nectar extracted by each nectar plant for each land separately was calculated and then the obtained indicators were summarized (Farkhutdinov et al., 2013; Al-Ghamdi et al., 2016).

On mixed vegetation land where honey species are most often placed very unevenly direct account of the number of plants per unit area is unacceptable (Aipov et al., 2018). To establish the number of plants of individual species per 1 ha of such land, a projective cover was determined as a percentage of the area of separately studied honey-bearing plants and transferred it to continuous herbage (Waldéna et al., 2017).

During the expedition studies conducted in the territory of the mountain-forest zone we made a cadastral assessment of honey resources in the most typical areas of the mountain-forest zone of the Republic. Creation of the inventory of honey plants is carried out step by step: inventory of species composition of nectariferous plants, determination of species diversity of honey plants in a certain area, nectariferous potential and its availability for honey bees and economic appraisal of the appropriate beekeeping production in the studied region. Assigning honey plant species to the inventory of natural honey resources we proceeded from the following provisions (Farkhutdinov et al., 2013):

• The species is a honey plant and (or) pollen in the region;

• The species belongs to the category of wild-growing ones frequently or very often found in the region;

• The presence of pollinating insects in the region with their sufficient natural density during flowering periods from early spring to late autumn;

• Description of foraging behavior of honey bees when collecting nectar, pollen and propolis;

• Accounting for naturally-growing plants pollen or nectar of which can be toxic to bees and cause trophic poisoning;

• Description of the flowering phase and pollination parameters (beginning, end and duration of flowering, pollination rate of flowers, the optimal number of pollinating insects per unit area or flowering, the number of bee colonies per 1 ha, etc.).

The cadastral evaluation of honey resources is based on the basic principles of evaluation of land and forest resources used in cadastral evaluation (Williamson, 2000; Kovyazin et al., 2015; Varlamov et al., 2016). Inventory of melliferous resources is a systematic set of documentary information about the environmental, economic and other quantitative and qualitative characteristics of melliferous plants of a particular region (Varlamov et al., 2016). Cadastral evaluation of honey resources includes: accounting for the floristic composition of honey plants in the studied area, the calculation of the appropriate productivity of honey and other bee products (wax, propolis, cerago, pollen, etc.), setting the territory with honey resources on the state cadastral registration with the definition of the legal regime and the cadastral value of the honey resource (Varlamov et al., 2016). The determination of appropriate production of bee products is calculated separately for woody and herbaceous honey plants and then summed up in a single cost indicator. The resulting amount is the cost of bee products in the studied region. Taking into account that this resource is renewable and depends on climatic and biotic factors the assessment is reliable when it is carried out in this area for at least 3 years.

Determination of the cadastral value of honey resources was carried out by assessing of the appropriate production (taking into account the availability of volumes) in accordance with the existing market prices for bee products (Varlamov et al., 2016).

Statistical Analysis

The results of our experiments were determined by the methods of variation statistics accepted in geo-botany and resource studies (Waldéna et al., 2017) using the program "STATISTICA". The reliability of the difference was determined using the criterion Student.

Results and Discussion

On the territory of the Altyin Solok Reserve was laid 30 test sites in the most characteristic areas of the studied area. Places of tabs of test sites are shown in Figure 1.

Forest resource assessment of the reserve showed that these forest tracts of the reserve are described as: *Tilia + Quércus +Aegopodium podagraria*, *Tilia + Quércus – Calamagrostis arundinacea + Brachypodium pinnatum*, *Pinus + Calamagrostis arundinacea + Brachypodium pinnatum*, normal and steppe meadows.

In the course of botanical descriptions on the territory of the Altyin Solok Reserve we established that 18 woody, 23 shrubby and 221 herbaceous plant species form the main and supporting honey collection in bee colonies.

In the test sites we made the accounting of wood honey-bearing rocks (*Tilia cordata Mill., Acer platanoides L., Acer tataricum L., Acer negúndo, Salix caprea L., Salix alba L., Salix acutifolia Willd, Salix Fragilis*). The honey-bearing resource of the fields was calculated by multiplying the area of the meadow (ha) by the average index of non-productivity

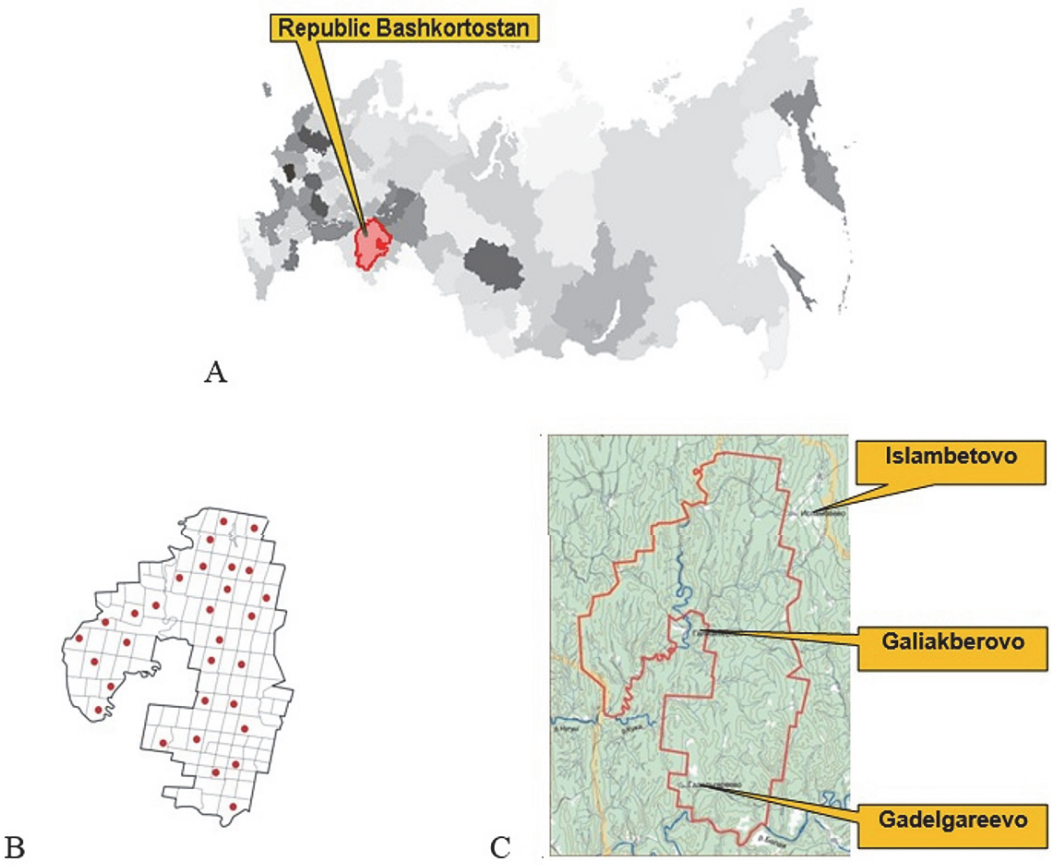

Fig. 1. The territory of the Republic of Bashkortostan (*A*), the Altyin Solok Reserve (*C*), places of laying test sites in the Altyin Solok Reserve (*B*)

of the accounting sites counted on 1 ha (Farkhutdinov et al., 2013).

Melliferous potential of each investigated plant communities was calculated on the basis of honey stock including phytocoenotic analysis, reference data for the production of nectar and pollen and the percentage of the melliferous species to the total number of species that characterize the biological community (Jarić et al., 2018).

Established honey plants form different communities and their share was different. The evaluation of nectar bearing capacity of glades, we have got a range of data from 4.5 kg/ha (prevalence in the community *Fragária virídis, Fragaria vesca, Achilléa millefólium and Origanum vulgare)* to 150 kg/ha in communities with a dominant share *Chamerion angustifolium*. Good nectar bearing production of bottomland sample plots in which *Heracleum sibiricum, Archangélica officínalis, Aegopódium podagrária, Angélica sylveństris* was dominated in an average of 70±15 kg/ha. The nectar production of the slopes of the mountains formed from the products of nectar *Caragana arborescens, Salvia stepposa, Echinops sphaerocephalus, Thymus marschallianus, Thymus talijevii, Thymus bashkirensis, rubens Allium, Allium obliquum, Allium microdictyon* and amounts 25-30 kg/ha in average. These data are given taking into account the fact that bees can only use 1/3 of the honey stock in the studied area. Many authors in the assessment of the honey productivity of the forest zone as a rule are often limited to the assessment of small-leaved Linden stocks that is not quite true. So, in 2018, lime tree plantings extracted a little of the nectar and respectively, feed stocks and marketable honey was obtained by the nectar of grassland clearings.

The calculations for determining nectar bearing capacity of the reserve we used the following indicators: percentage of available nectar for the bees in lime tree forests – 200 kg/ha; in the thickets of maple – 50 kg/ ha and the average productivity of the glades – 25 kg/ha to determine honey productivity of private area sites (Farkhutdinov et al., 2013).

As it can be seen from the data of Table 1 in the total hon-

ey reserve of the wildlife Altyin Solok Reserve the dominant culture is small-leaved Linden (91.5%) which is located very unevenly on the territory of the reserve (Table 2). Table 2 presents the results of studies characterizing the contribution to the nectariferous reserve of various honey-bearing lands represented in the mountain-forest zone of the Republic of Bashkortostan (Khisamov et al., 2018).

The main stocks of Linden are located in the Nugush forestry (arrays in sq. 36, 38, 46, 56, 57, 67, 70, 79 and 117). These quarters can be considered as the main ones for the organization of beekeeping. The most favourable ones are 46, 57, 70 and 117 in the territory, except of Linden there are thickets of maple (provides early spring development of bee colonies) as well as quite large areas of meadows, with mixed herbs which give early summer and late summer honey. Taking into account the instability of flowering and nectar of Linden the presence of alternative sources of nectar will save the number of bee colonies in lean years.

Norway maple is also not evenly represented in the reserve with predominance in the territory of Gadelgareevo forestry. The share of maple nectar reserves is 5.35%. On the territory of the reserve willow thickets which could be considered as a significant non-productive resource are not established.

In this forest area the share of mixed herbs in the honey stock accounts for 2.17%. These observations led to the conclusion that it is necessary to introduce a special inventory of honey-bearing areas with a predominance of honey-bearing vegetation which produces nectar in certain periods of time. This will allow us to organize the alternation of honey plants in time ensuring the life of the bee family.

Thus, the total nectar reserve of the wild Altyin Solok Reserve is 4324770 kg (Table 2). Taking into account the annual demand of 1 bee family in carbohydrate feed is 95 kg in average and the average rate of production of marketable honey is 25 kg, it is necessary to produce 120 kg of honey per bee family (Farkhutdinov et al., 2013). If we assume that the average concentration of sugars in the nectar is 40-50%, and in honey 80%, it is possible to make a conversion of the nectar stock on honey which results in that the total honey stock (HS) should be approximately 2162385 kg of honey which is used by bees about 33%. As a result the available honey reserve stock is 720795 kg of honey. The maximum number of bee colonies that can be kept in the reserve is determined by the formula HS: 120 = 720795: 120 ≈ 6000 bee colonies.

The radius of the productive bee flight is about 2.5 km which is 1962 ha (Farkhutdinov et al., 2013). Thus, one ra-

Table 1. The proportion of nectar honey plants in the wild Altyin Solok Reserve and the potential of honey reserves

Honey lands	Share of the nectar stock, %	Nectariferous stock, kg	Honey stock, t
Lime tree forests	91.5	3999060	1999.5
Norway maple	6.4	231725	115.9
Mixed herbs of the glades	3.1	93985	46.99
Total	100	4324770	2162.4

Table 2. Areas of the main honey plants and appropriate honey productivity of forest areas blocks that are parts of the Altyin Solok Reserve

The regional forestry	Total area, ha	Linden, ha	Maple, ha	Glades*, ha	Nectar productivity of the quarter, kg
Gadelgareevo forestry	29163.0	5587.4	2732.3	1147	1282770 including Linden – 1117480 maple – 136615 glades – 28675
Nugush forestry	56294.0	14392.4	1695.5	2455.4	3024640 including Linden – 2878480 maple – 84775 glades – 61385
Belskoye forestry	2319.0	15.5	206.7	157	17350 including Linden – 3100 maple – 10325 glades – 3925
Total in the Altyin Solok Reserve	87776.0	19995.3	4634.5	3759.4	4324770 including Linden – 3999060 maple – 231725 glades – 93985

Table 3. The appropriate volume of production and the cost of bee products in the Altyin Solok Reserve (acc. to 2018 prices)

Beekeeping products	Volume of production, kg	Price per kg, Rub/USD	Cost, thousand Rub/USD
Lime honey	718795	200/3.33	143759/2396
Wild hive honey	2000	900/15	1800/30
Pollen cover	12000	600/10	7200/120
Cerago	6000	1200/20	7200/120
Propolis	600	2000/33.3	1200/20
Wax	6000	290/4.8	1740/29
Total			162899/2715

tional (by the number) apiary of 120 bee families can account for an average of 3-4 quarters of the forest, and the honey reserve of the area should be 14400 kg of honey or in terms of 40-50% of nectar and 33% of nectar availability to bees – 72000 kg of nectar or in terms of 1 bee family 600 kg. At the same time this will require the development of special schemes and projects of forest and land management. At the same time the money spent for it can be compensated for 3-5 years (Farkhutdinov et al., 2013).

Many quarters of the reserve (including the Belskiy forestry) have a small nectar reserve and were excluded by us from the estimated data on the organization of apiary beekeeping. Such quarters can be used for the development of traditional wild hive beekeeping for Bashkiria with a smaller amount of honey. But it is about 5-10 times more expensive than the centrifugal produce obtained in stationary apiaries (Yumaguzhin, 2010). In addition to this due to the small number of settlements and undeveloped road network (represented mainly by dirt roads), many quarters with good honey reserves are inaccessible and can only be used for organizing summer migrations to the main honey collection from Linden.

Taking into account the fact that except the honey production rational beekeeping involves the production of wax, propolis, bee stump and cerago it is also necessary to assess the appropriate production of all bee products (Table 3). The value of the average rate of collection of marketable honey per bee family is calculated according to the data for a particular region for the last 2-3 years. In average, for the mountain-forest zone of the Republic of Bashkortostan it is optimal to obtain 15-20 kg of centrifugal honey (4-6 kg of honey), up to 2 kg of pollen, 1 kg of cerago, 100 g of propolis and 1 kg of wax (Farkhutdinov et al., 2013). In this case the appropriate production of these biologically active bee products will bring tangible profits (Varlamov et al., 2016; Tran and Lien, 2018). Thus, according to our calculations on the territory of the Altyin Solok Reserve it can be obtained theoretically 720.8 thousand kg of honey (including 2000 kg of wild hive), 112 thousand kg of pollen, 6 thousand kg of pollen and wax as well as 600 kg of propolis.

On the basis of the quarterly assessment of the state reserve territory "Altyin Solok" we have produced a map of bee pasture areas approved with forest and land management zoning of the territory, indicating the maximum possible number of bee families in each quarter as well as the type of bees content (apiary or wild hive) (Figure 2).

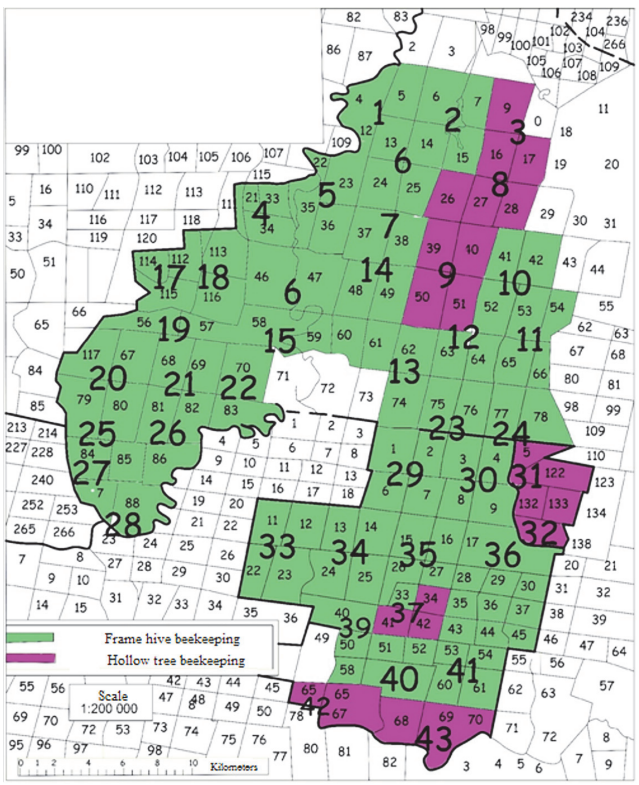

Fig. 2. The map of the type of bee colonies content in the Altyin Solok Reserve: blocks where recommended apiary content of bee families are green highlighted; purple – wild hive content; small numbers – numbers of forest inventory plots; large numbers – numbers of bee pasture sites

The state of the melliferous flora of the Altyin Solok Reserve is an important foundation for the preservation of the genetic pool of the Burziyan wild population of the dark forest bees. For rational and more productive use of the forage base it is necessary to take into account the honey-bearing flora and assess the opportunities for the long-term development of beekeeping. The result of the successful implementation of all security measures in relation to the dark forest bee in the Republic of Bashkortostan can be the restoration of aboriginal pure genetic pool within the range of the Burzian habitat.

During the assessment of the floristic composition of the main honey plants of the Altyin Solok Reserve the nectariferous potential of the reserve was determined. It was found that 18 trees, 23 shrubs and 221 herbaceous plant species are nectareous. 94 species of honey plants form the main and supporting honey collection of bee colonies. It was found that the dominant honey plant in the reserve is small-leaved Linden (*Tilia cordata Mill.*) which forms more than 90% of the honey reserve of the studied area. According to this indicator and the share of lime plantations in the forest fund the forests of Bashkiria exceed the indicators in Russia (Kulakov & Rusakova, 2002; Kurmanov et al., 2014) as well as other countries in Asia and Europe where there are lime plantations (Stolarikova et al., 2014; Gil & Zajaczkowski, 2017; Guo et al., 2017; Tavankar et al., 2018).

In the study area nectar productivity lime-trees and thickets of maple was determined quarterly. It is possible to determine the possibility of using of the dominant forage during spring development (maple) in the territory and for receiving marketable and feed honey by means of the lime-trees. The role of mixed herbs of forest glades in the formation of supporting honey collection in the conditions of the Altyin Solok Reserve was separately evaluated. In this respect their share of the honey stock is relatively small and less than in other territories of the Russian Federation and abroad (Jitariu et al., 2014; Samsonova, 2015; Díaz-Forestier et al., 2015; Méndez et al., 2018). The role of nectariferous plants forming a supportive honey flow for bee colonies is very important because it provides spring development and preparation of the bee colony for winter after the main honey flow (Singh et al., 2007; Grozeva & Budakov, 2010; Stawiarz & Wróblewska, 2010). Our assessment also showed their important role despite the relatively low honey-producing potential of herbaceous plants (about 3%). Among the stimulating spring development of bee colonies is maple (Farkas & Zajácz. 2007), the thickets of which are well represented in the Altyin Solok Reserve. When determining the number of locations of bee families on the territory of the forest management quarter it is necessary to assess the presence of thickets of maple and also trees which are a source of substances for the production of propolis (König 1985). For the organization of cost-effective beekeeping it was assessed the appropriate volume of production and the cost of bee products that can be produced in the Altyin Solok Reserve. For rational use of forage resources the map of quarterly zoning of the reserve territory on the organization of bee-pasture sites with designation of wild hive or apiary type of the maintenance of bee families in the territory of the reserve was made. This approach is used in a number of countries to plan the production of bee products (Van Engelsdorp & Meixner, 2010; Hoover & Ovinge, 2018).

We have developed a method of complex assessment of the bee forage including floristic description of nectar plants, the definition of nectar bearing capacity of territories for productive bees flight and a form of a rational organization of bee families content as well as the cadastral evaluation of melliferous resource and appropriate production of bee products is not used in a single integrated assessment in our country and abroad. As a rule these studies are carried out separately without the formation of a single cadastral assessment of honey resources of a certain region. This comprehensive assessment is quite universal and it can be used in any region to assess the area where beekeeping is introduced for the first time and to optimize the content of bee colonies in the developed areas.

Conclusions

The territory of the Altyin Solok Reserve meets the requirements for reproduction and preservation of purity of the genetic pool of the Burzian dark forest bee *Apis mellifera mellifera*. As a result of the research it was found that the floristic composition of honey biocenosis of the reserve is not very uniform and depends on the terrain features, slope expositions and other growing area conditions. Main honey plants are 18 trees, 23 shrubs and 221 herbaceous species. 94 species of honey plants form the main and supporting honey collection in the Altyin Solok Reserve. In 24 forestry allotments it was determined that honey resources cannot provide sufficient nectar extraction for the bee colonies content in a stationary apiary. In this regard, it is recommended to keep bee colonies in single hives of natural origin (hive) or made by beekeepers – deck.

Determination of the volume of honey potential showed that the dominant nectariferous plant in the reserve is small-leaved linden *Tilia cordata Mill*. It accounts for more than 90% of the appropriate nectar production. In favorable years in the reserve it can be obtained about 720 t of lime honey of which about 2 t are wild hive honey. On the territory of the Altyn Solok Reserve in addition to the production of centrifugal and wild hive honey 112 t of pollen, about 6 t of cerago and wax as well as 600 kg of propolis can be obtained. The map of bee pasture sites and the results of the assessment clearly show that 43 bee pasture sites can be created on the territory of the reserve "Altyn Solok" with the maximum possible placement of about 6000 bee families.

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