Productivity and resources of bird cherry (family *Padus*) in Russia

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Abstract. The paper presents data on distribution and confinement of *Padus* (bird cherry) species in Russia. It shows productivity, raw material stocks of the studied species within Federal districts and characterises trophic role of bird cherry fruits in wild animals’ nutrition. Decrease of collection and utilisation volumes of raw material is marked.

1. Introduction

Bird cherry (*Padus avium* Mill. In Gard.), family *Rosaceae*, Euro-Asiatic species with disjunctive range, it occurs in the European part of Russia, Caucasus, Western and Eastern Siberia, Anmur river area, Primorye, The Sea of Okhotsk coastline, Kamchatka, and Sakhalin Island.

Bird cherry range predominantly covers the forest zone, in southern parts of Western and Eastern Siberia and European Russia it spreads along river floodplains to the steppe zone, in Eastern Siberia and Far East the species does not go northwards farther than middle taiga, it can also be found up to the mountain forest level.

Bird cherry fruits are used for medicinal purposes and in food industry. In spite of growing interest to different types of plant raw material in medicine [1,2], nutrition [3], mainly as sources of antioxidants [4], resources remain insufficiently studied. Bird cherry is also widely used in landscaping and urban greening being a hugely decorative species resistant to human impact [5].

The species is morphologically variable [6-8], that allowed forming a variety of cultivars for decorative and nutrition use [9] designed for harsh weather conditions.

It is known that bird cherry is an important component of animals’ nutrition, especially birds [10,11].

Bird cherry typically occupies second storey of coniferous, mixed and broad-leaved, mostly floodplain forests, forest edges, and openings, where it forms thickets [12].

The species is found in the understorey of moist and wet forest types, but mostly in A3 - BC4; C3 - C5; D4 ecotopes, presented by sparse spruce, birch and aspen forests of stream, herbaceous-bog, and equisetum-moss types, in shrub thickets on floodplain meadows and on 8-15 years old openings. The most productive fructification of bird cherry is marked on forest edges, openings, fire sites, forest meadows, and along rivers on moist soils.

Commercial areas include openings and river floodplain wet forests with low density (0.2 – 0.4), where bird cherry occupies sparse areas, edges, and glades. In the northern part of its range the species rarely occurs on openings, compared to central and southern parts, and is mostly spread along floodplain complexes.
First ripe fruits of bird cherry appear in July, mass ripening is marked in the first decade of August. Bird cherry abundantly blossom annually, but fructification is unstable due to spring frosts that damage flowers, and droughts causing sets to fall. During the last 20 years mass pest damages are being marked.

In all districts of Russia, except for the Far East, fruits are the subject of organized collection. Productivity of bird cherry fruits reaches 1170 [2] - 1406 kg/ha [13,14] depending on the zone and plant community type.

2. Results and discussion

Investigations in Kirov region which can be considered a model for taiga zone area of the country, shown that maximum average productivity is marked on openings in middle taiga (124.7 ± 13.6 kg/ha) (table 1). Average productivity of bird cherry in forest plant communities of southern and middle taiga and coniferous-broad leaved forests during the years of good yields were not statistically different (P> 0.05).

Table 1. Productivity of Padus avium Mill. inGard. in different vegetation subzones and plant communities in Kirov region in the years of different fructification intensity, kg/ha, (min – max / average).

| Plant community type | Intensity of fructification | Openings | Forest plant communities |
|----------------------|-----------------------------|----------|--------------------------|
|                      | low                         | medium   | high                     | low          | medium     | high       |
| Middle taiga         | 10 – 40                     | 60 – 70  | 90 – 130                 | 10 - 30      | 30 – 50    | 90 – 100   |
|                      | 25.0 ± 2.8                  | 67.1 ± 6.9 | 124.7 ± 13.6             | 26.7 ± 3.8  | 53.3 ± 6.1 | 100.0 ± 9.8 |
| Southern taiga       | 20 – 50                     | 50 – 80  | 70 – 120                 | 20 – 60      | 40 – 95    | 60 – 150   |
|                      | 37.1 ± 3.9                  | 66.6 ± 7.6 | 94.5 ± 11.0             | 39.3 ± 4.2  | 79.1 ± 8.3 | 111.2 ± 13.6 |
| Coniferous-broad     | 30 – 50                     | 50 – 80  | 70 – 100                 | 30 – 60      | 60 – 90    | 80 – 150   |
| leaved forest        | 33.3 ±3.7                   | 52.9 ± 6.2 | 76.7 ± 8.3             | 37.9 ± 3.9  | 83.6 ± 9.1 | 108.6 ± 12.3 |

Long-term average productivity of the species in the European part of the range usually reaches 100 – 120 kh/ha, in Asian – 40 – 120 kg/ha. The estimate is close to the published data in taiga and subtaiga zones of the country. EV Zueva [15] states that average productivity of bird cherry in southern areas of Arkhangelsk region in floodplain forests and shrub thickets depends on the ecotope conditions, mostly light, drainage and soil moisture, and varies from 21 to 195 kg/kg in fruitful years, average 50-70 kg/ha, maximum being on well-lit areas. In Eastern and south-eastern areas of Perm region bird cherry productivity varies from 99 ± 9 kg/ha to 248 ± 34 kg/ha, in mountain-forest part of Chelyabinsk region—from 39 to 420 kg/ha [16], in Sverdlovsk region—from 267 to 1406 kg/ha[13,14]. High values of bird cherry productivity were defined by NA Nekratova et al. [17] in some plant communities of Tomsk region. Maximum value for Tomsk region is marked in gramineous-mixed hers shrub thickets in floodplains of large rivers - 450 kg/ha. The productivity is almost twice that lower in floodplains of small rivers (256 kg/ha). Minimal values are marked in poplar and willow-poplar shrubby sparse forests of calamagrostis-nettle type– 58 kg/ha. In low-hill terrains of Altai under sparse forests of herbaceous, fern, herbaceous-bog types, and on old openings and fire sites in river floodplains bird cherry productivity reaches 150-200 kg/ha, according to the estimates of YuP Surov[18]. In forest-steppe and steppe zones (e.g. steppe rivers floodplains and low-hill terrains of Bashkiria) bird cherry shows significantly lower values of productivity 6 – 70 kg/ha, in southern areas of Irkutsk regions– 25,07 kg/ha [19].

Comparison of scoring and quantitative estimations allowed revealing their ratio (table 2) for accurate definition of pre-collection productivity value for practical purposes.
Table 2. Productivity of *Padus avium* Mill. in Gard. at different score estimation (average for plant communities) in Kirov region.

| Score     | Productivity, kg/ha |
|-----------|---------------------|
| 3.8 – 5.0 | 100.0 ± 16.0        |
| 2.6 – 3.7 | 60.0 ± 10.0         |
| 1.0 – 2.5 | <30                 |

Area of bird cherry thickets in Kirov region reaches 179.2 thousand ha. They are almost equally distributed between the subzones of middle (49% from total thickets area) and southern taiga (46% from total thickets area). Share of bird cherry thickets in the subzone of coniferous-broad leaved forests is insignificant (5% from total thickets area). Fruit-bearing area reaches 12.4 thousand ha. Main fruit-bearing areas of bird cherry are also located in middle (49%) and southern (44%) taiga subzones. Minimal (7%) fruit-bearing area is marked in coniferous-broad leaved forests subzone (table 3).

Table 3. Fruit-bearing area and stock of fruits of *Padus avium* Mill. in Gard. in different subzones of Kirov region.

| Subzone                  | Thickets area, thous.ha | Fruit-bearing area, thous.ha | Biological stock, t | Exploitation stock, t |
|--------------------------|-------------------------|-----------------------------|---------------------|-----------------------|
| Middle taiga             | 87.7                    | 6.1                         | 161.2 – 681.3/455.6 | 180.1                 |
| Southern taiga           | 82.2                    | 5.5                         | 202.2 – 593.5/410.6 | 195.3                 |
| Coniferous-broadleaved forest | 9.3                    | 0.8                         | 26.9–79.5/59.2      | 39.7                  |
| Total                    | 179.2                   | 12.4                        | 925.4               | 415.1                 |

Availability of thickets has increased during the last years and now reaches 50-70% in northern, 60-80% - in central, and 70-98% - in southern parts of the region.

Biological stock of bird cherry in the region varies from 390.3 t to 1354.3 t, average ~925.4 t. Half of the biological stock is concentrated in northern taiga subzone (50%) (table 3), a little less - in southern taiga (44%), and only 6% – in coniferous-broad leaved forests.

Biological stock of bird cherry in Kirov region is significant and close to the value of bordering areas: 620 t in Mary-El Republic, 308 t – in Perm region, 1295 – in Sverdlovsk region. In some regions of Siberia bird cherry biological stock is greater by an order, e.g. 22.0 thous.t. in Tomsk region, 15.0 thous.t – in Novosibirsk region, and 12.0 thous. t – in Kemerovo region.

In average fruitful years Kirov region produces only 0.9% bird cherry of biological stock in Russia. Northern and north-eastern areas of Kirov region are characterized by maximum value of biological stock: Verkhnekamskyi (117.8 t), Oparinskyi (96.4 t), Omutinskii (96.1 t), and Belokholunitskyi (83.1 t).

Relative density of bird cherry biological stock in the region in low. Values over 0.01 kg/km2 are marked in 7 administrative districts of the region, predominantly northern: Omutinskyi(0.018), Murashinskiy (0.017), Oparinskyi(0.016), Belokholunitskyi(0.016), Nagorskyi (0.013), Afanasyevskyi (0.011), Verkhnekamskyi(0.011).
At high and medium productivity levels exploitation stock of bird cherry in the region is less than half of biological (44.8%) and reaches 415.1 t. Half of exploitation stock is located in middle taiga (50%), 44% - in southern, 6% - in coniferous-broad leaved forests.

Exploitation stock of bird cherry in Kirov region is 1.5-4.0 times higher than on bordering territories: 166 t – in Novgorod region, 102.4 t – in Perm region, 278.0 t – in the Mary-El Republic.

In average fruitful years biological stock (BS) of bird cherry fruits in Russia reaches 106.2 thous.t, exploitation stock (ES) – 38.0 thous.t (table 4). More than 76.0% of total BS is concentrated in Siberian (BS - 81.7 thous.t, ES – 22.0 thous.t), around 8% - in Far Eastern (BS – 8.4 thous.t, ES – 2.8 thous.t) and Ural (BS – 8.3 thous.t, ES – 3.2 thous.t) Federal District.

| Federal district | Biological stock, thous.t. | Exploitation stock, thous.t |
|------------------|-----------------------------|-----------------------------|
| North-western    | 2.1                         | 0.6                         |
| Central          | 1.6                         | 0.5                         |
| Privolzhskyi     | 4.0                         | 1.6                         |
| Ural             | 8.3                         | 3.2                         |
| Siberian         | 81.7                        | 22.0                        |
| Far Eastern      | 8.4                         | 2.8                         |
| Total            | 106.2                       | 30.8                        |

Fruits of bird cherry are collected for drying as a medicinal and food raw material. In 1980’s annual collection for medicinal purposes varied from 148 to 170 t of dry birch cherry fruits, mostly originated in Krasnoyarsk Krai, Republic of Bashkortostan, Udmurt Republic, Altay Krai, Penza, Kirov, Kostroma, Yaroslavl, and Smolensk regions. During the period Kirov regional costumers association (Oblpotrebovoyz) collected 0.8-44.5 t of bird cherry fruits and regional Board of Pharmacy (Aptekoupravleniye) - 2.3 to 21.0 t. Since 2000 bird cherry collection resumed in several districts of Russia, but the volumes are low. Annual collection of the raw material in Kirov region in 2000-2015 did not exceed 0.9-5.1 t. During the last 5 years volumes were even smaller.

3. Conclusion
The investigation revealed the following. Maximum long-term average productivity of bird cherry is marked on the openings in middle taiga (124.7 ± 13.6 kg/ha). Industrial collection is possible on openings and floodplain sparse (0.2 – 0.4) wet forests, where bird cherry occupies glades and edges.

Biological stock of fruits in Russia in medium fruitful year reaches 106.2 thous.t
Decrease of collection is being marked during the 21st century.

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